A Private Cloud Infrastructure for Desktop Virtualization & Application Delivery Based on Xen

Dissertation submitted in partial fulfillment of the requirements for the degree of

Master of Technology

in

Electronics and Communication Engineering

by

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Rourkela – 769 008, India

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CERTIFICATE

This is to certify that the work in the thesis entitled **"A Private Cloud Infrastructure for Desktop Virtualization and Application Delivery Based on Xen"** submitted by **Priyanka Mittal** in partial fulfillment of the requirement for the award of the degree of Master of Technology with the specialization of Communication & Networks in the Department of Electronics & Communication Engineering, National Institute of Technology, Rourkela is a record of an original research work done by her during 2013-2014 under my supervision and guidance. The result incorporated in the thesis has not been submitted for award of any degree elsewhere.

Place: Rourkela

Date: 26/05/2014

Prof. Poonam Singh
Department of ECE
NIT Rourkela

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Priyanka Mittal

Abstract

Todays computing environment requires IT departments to confront more PC management challenges than they did just a few years ago. With the increment in the complexity of software, more computing power is required for their execution resulting in cost and maintenance to surge up. Additional challenges stem from the need to access applications and data anywhere and from any device. To reduce maintenance, cost and time, desktop virtualization and application delivery come handy. Desktop virtualization prospects to offer a new, cost efficient paradigm shift to cater the demand for resources while amplifying the return on investment. Additionally, desktop virtualization can provide more dynamic streamlined management by isolating the elements of the traditional desktop computing stack. So, virtualized desktop is the key to progress towards a pervasive computing in cloud computing era. As the pace of cloud adoption accelerates, a high degree of flexibility will be the clue to architecting environments that provide for highly secure and available application delivery. This thesis describes the design, installation and deployment of a private cloud using Xen open sourced software solutions within the organization. A private cloud is setup in a virtualized environment of VMware hypervisor for virtual desktop delivery and application streaming to remote users on the LAN through a browser interface over a secured connection. The users of this service would be able to remotely login and access the virtual environment using the given authorized id over the browser.

***Keywords*:** Private Cloud, Virtualization, XenServer, Openfiler, Xen WSS, Virtual machine, Application Streaming.

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Abbreviations

$ADDS$: Active Directory Domain Services
API : Application Programming Interface
CDB : Command Descriptor Block
$CIFS$: Common Internet File System
CLI : Command Line Interface
DC : Domain Controller
DNS : Domain Name System
$FQDN$: Fully Qualified Domain Name
GUI : Graphical User Interface
$IaaS$: Infrastructure as a Service
ICA : Independent Computing Architecture
IIS : Internet Information Services
IP : Internet Protocol
IT : Information Technology
IQN : iSCSI Qualified Name
$iSCSI$: Internet Small Computer System Interface
LAN : Local Area Network
$LDAP$: Lightweight Directory Access Protocol
LUN : Logical Unit Number
LVM : Logical Volume Manager
MMC : Microsoft Management Console
NAS : Network Attached Storage
NTP : Network Time Protocol
$PaaS$: Platform as a Service
PC : Personal Computer
$PATA$: Parallel Advanced Technology Attachment

$RAID$: Redundant Array of Independent Disks
RAM : Random Access Memory
$SaaS$: Software as a Service
$SATA$: Serial Advanced Technology Attachment
SLA : Service Level Agreement
SQL : Structured Query Language
SR : Storage Repository
TCO : Total Cost of Ownership
TCP : Transport Control Protocol
URL : Uniform Resource Locator
$UUID$: Universal Unique Identifier
VDA : Virtual Desktop Agent
VDI : Virtual Desktop Infrastructure
VHD : Virtual Hard Disk
VM : Virtual Machine
VMM : Virtual Machine Monitor
VPN : Virtual Private Network
WAN : Wide Area Network
WSS : Web Self Service

Chapter 1

Introduction

1.1 Introduction

Cloud Computing represents a strategic generational shift in how IT operates. It is a model promising more efficient use of hardware resources through virtualization, provisioning mass deployment services, elastic resource capacity and flexible functioning. Cloud Computing abolishes the need for a large up-front capital investment and allows for creation of an elastic pool of compute, storage and networking resources that can be utilized on an on-demand basis [1-3].

As cloud delivery model requires multiple operating environments, the hypervisor forms an ideal delivery mechanism. A hypervisor is a piece of software that allows a single hardware machine to host multiple operating systems concurrently. It manages and allocates resources in a way as to allow mutual working of various OS without disrupting each other. VMware Workstation [4, 5] is a comprehensive hypervisor that runs within a conventional OS environment and supports bridging existing host network adaptors & share physical disk drives and USB devices with a virtual machine. The server forms the centre of the cloud infrastructure, virtualization of which facilitates one physical server to support multiple workloads in simultaneously running virtual machines.

Citrix XenServer [12] provides server virtualization and abstracts elements from the physical machine to the virtual machines it hosts upon itself [6-8]. XenServer

allows the workload to float across a pool of physical computing resources and provides virtual networking features facilitating connection of virtual infrastructure to be deployed over the network. Leveraging the full capabilities of Citrix XenServer requires shared storage.

Openfiler is a free storage management system that caters the storage requirement of virtual machines using block-based iSCSI (Internet Small Computer System Interface) technology [9]. Due to the open nature of iSCSI [10], the same storage repository can be inherently shared by multiple XenServers in a resource pool encouraging a load balanced environment.

XenCenter [7, 8] catalyzes easy deployment, management and monitoring of VMs along with extensive configuration tools such as workload balancing, role based access control, system performance monitoring, dynamic memory sharing, high availability, VM protection and recovery. The XenServer VMs are created by template provisioner using the iSCSI virtual disk storage.

The Web Self Service portal alleviates the complexity, development cost, maintenance and delivery of virtual workloads and empowers application owners to oversee the day to day administration of their VMs. A remote display protocol such as ICA is used by the physical desktop clients to connect to a virtual machine (VM) that's running on the back-end virtualization server. This Multi-VM network model is based on client-server model with the windows-based domain controller providing DNS and Active Directory Domain Services [11].

The crux behind what is called a Virtual Desktop Infrastructure (VDI) is to run desktops and applications inside virtual machines that reside on servers in the data centre. With such an approach, multiple virtual servers run on single physical host and computing resources are consumed based on each application's requirement. The idea also helps to eliminate the costly refresh cycle of corporate PCs. Nurturing this concept, Citrix XenDesktop centralizes and securely delivers desktops to users anywhere at any time & enablesreduction in management chores & operating costs.

Another major field of outsourcing from cloud is secured application delivery. Application virtualization is an approach for segregating an application from the underlying system and provision mobile access to applications. XenApp is an

on-demand application delivery mechanism that permits any Windows application to be virtualized, streamlined, & supervised in the datacenter and promptly delivered as a service to users releasing any device-oriented restriction on delivery platform including Windows, Linux and Android platforms.

1.2 Motivation of work

The emergence of the cloud has led to an entirely new level of techniques for servicing individual users. Experts say the personal cloud shall commence a new age that shall empower consumers with a new degree of flexibility in the way devices are used along with leveraging the virtue of each device, essentially achieving higher levels of productivity and user satisfaction. Nevertheless, the companies need to fundamentally review the delivery process of applications and services to the users.//

The construction of this new era is being influenced by multiple driving forces. These bubbling trends have seeds that root back through the past decade but are building in a modern regard.

(i) **Consumerization**

The consumerization of Information Technology has proved to be a progenitor to the upcoming wave that is beginning to take a stand across all facets of information technology as various key components transpire together:

(a) The now technologically savvy users have high expectations of technology.

(b) Through the democratization of technology, users of various domains, types and status within the enterprise can avail similar technologies.

(c) The equation for users has undergone a huge shift due to soaring up of substantial, affordable mobile gadgets.

(d) Users have turned into innovators.

(ii) **Virtualization**

The choices IT enterprises have to implement client locale has become more flexible with the presence of virtualization. Virtualization has, in a huge

way, relieved applications from the peculiarities of device lock-ins, operating systems and even processor architectures. It offers a path to extend the legacy of processes & applications developed in the PC era ahead into the new emerging world. This allows low-power devices to gain access to much-greater computing power, thus increasing their utility and stretching the range of processor-intensive applications.

(iii) **"App-ification" From Applications to Apps**

When the aspects of application design, delivery and consumption by the consumer changes, it has a profound influence on all other deportment of the market. These transformations will have a tremendous impact on application management & usage in corporate surroundings.

(iv) **The Ever-Available Self-Service Cloud**

The prospects for IT infrastructures are stunning, but from an individual scenario, there are some distinct benefits that surface. Users' digital activities have become much more self-directed than ever before. Consumers desire to pursue their own choices about services, applications & content, choosing from a nearly limitless collection on the Internet. This promotes a culture of self-service that users contemplate in all aspects of their digital encounter.

(v) **The Mobility Shift Wherever and Whenever You Want**

Now-a-days, mobile devices in accord with the cloud are able to effectuate most processing tasks, and outweigh any trade-offs existing in the minds of the user by the virtue of flexibility & convenience provided by the mobile devices. Touch & gesture based user interfaces, coupled with voice and contextual intelligence, and are facilitating rich device interaction & a much higher freedom level.

Motivation has been derived from this principle to design and implement an in-house private cloud infrastructure for providing virtualized desktop environment to the end-user over the home network.

1.3 Thesis Objective

Outsourcing IT needs and resources is a vital and indispensable move for enterprises that want to sustain in the highly competitive climate. The work done here intends toprovide an open source solution for low cost computing using desktop virtualization and secured delivery of applications over the network which can be used by small enterprises and educational institutions. The objective is to setup a private cloud in a virtualized environment of VMware hypervisor for virtual desktop and application delivery to remote users on the LAN through a browser interface over a secured connection.

1.4 Thesis Layout

The thesis has been organized into six chapters. The current chapter gives the introduction to cloud computing and discusses the importance of virtualization in improving flexibility and utilization of resources. The motivation and the problem statement have been discussed in the penultimate sections while the last section describes the complete thesis organization.

Chapter 2: An insight into Cloud Computing The second chapter describes the key features and service models of the cloud and discusses the merits and demerits of the same and elaborates the role of virtualization in conjunction with cloud service deployment.

Chapter 3: Private Cloud Server Side Architecture The third chapter discusses the private cloud server side architecture charting the role of each component in readiness of the infrastructure.

Chapter 4: Private Cloud Client Side Architecture The fourth chapter discusses the private cloud client side architecture revealing how users shall access their desired desktop and applications.

Chapter 5: Performance Analysis The fifth chapter presents the performance analysis of the cloud architecture in terms of monitoring and management mechanisms.

Chapter 6: Conclusion The sixth chapter outlines the conclusion to the complete work and talks about the scope of future work to the research work that has been presented in the thesis.

Chapter 2

An Insight into Cloud Computing

2.1 Introduction

Cloud is the latest evolution of computing that has the prospective to alter the face of IT, especially the delivery of sophisticated on demand configurable computing services. Cloud computing permits people to gain access all of their software & digital documents while on the move & that too with a simple input output device using a decent connection to the internet.

As a metaphor for the Internet, "the cloud" is a familiar clich, however when unified with "computing," the meaning gets bigger and fuzzier. Cloud computing is a comprehensive answer to creating a fundamental change in computer architecture, software and tools development, & revolutionising the methods of data storage, distribution and consumption of information. The systems in the cloud are configured to work in conjunction & delegate the use of computing power as a single source.

2.2 Key features

The key features are

(i) **Resource Pooling and Elasticity**

Resources are dynamically allocated & released from a service pool to serve a

huge number of users.

(ii) **Self-service and On-demand service**

Cloud computing allows user to interact with the cloud & authorizes an on-demand self-service methodology under a subscription-based billing method.

(iii) **Pricing (pay per use)**

Cloud computing completely depends on usage & has no upfront cost.

(iv) **Quality of Service**

The assurance of reliable automated service as outlined in the service-level agreement is vital.

(v) **Application Programming Interface**

A cloud API serves as an interface to provisioning of direct & indirect cloud infrastructure and software services to the consumers.

(vi) **Device and Location Independence**

Cloud models enable users to connect and utilize resources and services regardless of their location and device.

(vii) **Virtualization**

Virtualization is the essential catalyst for cloud computing to abstract the complexity of managing the IT infrastructure and facilitate the seamless creation of an elastic pool of compute, storage & networking resources that can be utilized on an on-demand basis.

(viii) **Multitenancy**

It enables a single instance of resource to serve a large pool of users thus allowing for the following.

(a) Centralization

(b) Peak-load capacity Handling

(c) Utilization & Efficiency

2.3 Cloud service models

A Cloud delivery model is categorized into three classes as shown in Fig. 2.1. Based on the type of services, these are:

(i) **Software as a service (SaaS)**

It is typically constigitutes of applications deployed directly to the end-users over the network. The basic idea is to provision software services over a Web browser using a multi-tenant architecture without any upfront investment from the user. Major SaaS providers are Googles Gmail, Zimbra webmail service, salesforce.com, Microsoft Office365 etc.

(ii) **Platform as a service (PaaS)**

PaaS delivers a computing environment with scalable processing which includes servers & database to cater the requirement of developers to design & deploy applications without worrying about the underlying hardware layer. It can be viewed as an advancement of Web hosting. Major PaaS providers are Googles App Engine, Microsoft Azure & Force.com.

(iii) **Infrastructure as a service(IaaS)**

A cloud infrastructure enables on-demand provisioning of compute foundation including servers running several choices of operating systems and a customized software stack. It delivers raw IT resources packaged into simplified customized infrastructure, provided on demand. Major IaaS providers are Amazon, Rackspace & IBM.

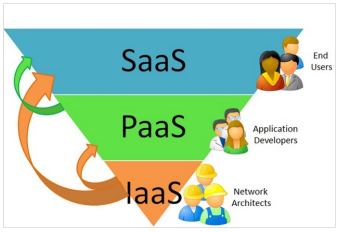


Figure 2.1: Cloud service models

2.4 Cloud Deployment Models

Depending on the usage of clouds in various sectors, the deployment of the clouds can be classified into three classes as shown in Fig. 2.2.

(i) **Private Cloud**

It is a secured enterprise class cloud deployment technique where the computing infrastructure is exclusively devoted to a specific organization & business. A further classification yields the following sub-category.

(a) On Premise Clouds

(b) Externally Hosted Clouds

(ii) **Public Cloud**

Public cloud is the traditionally accepted publicly accessible cloud infrastructure whereby resources are dynamically allocated by a third party provider. It provides highly agile and scalable infrastructure built into a pay as you use model. Security concerns are higher than that posed by the private cloud and must be collectively tackled by the provider and the tenant.

(iii) **Hybrid Cloud**

A hybrid cloud has two or more discrete cloud types but networked together such that a burst of activity beyond the capabilities of one cloud is shifted for processing to another. This technique amalgamates the positive traits of both the Public & Private Cloud paradigm.

(iv) **Community Cloud**

A community cloud is cloud that is targeted to be shared by a limited set of enterprises and supports a specific community that has similar issues & concerns.

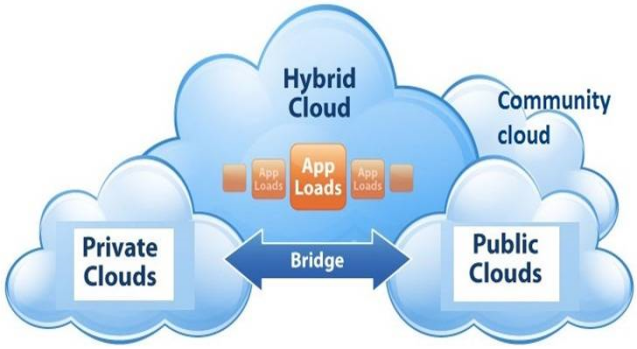


Figure 2.2: Cloud Deployment Models

2.5 Pros and Cons of cloud computing

Like any other technology, Cloud Computing too has several advantage & disadvantage. They are depicted below.

Advantages

(i) Simplicity

(ii) Cost Effectiveness

(iii) Scalability

(iv) Business agility

Disadvantages

(i) Cloud Security

(ii) Governance

(iii) Vendor lock-in

2.6 Importance of virtualization in cloud computing

Virtualization technologies have emerged as the key, over the last few decades, for improvements in network performance and utilization of resources. Virtualization authorizes multiple virtual machines with guest OS to run simultaneously & independently, on the same hardware machine as shown in Fig. 2.3. It is a decoupling process that isolates system software from hardware platform while allowing applications to run pervasively.

Server virtualization is principally focused on boosting up efficiency and bringing costs down. IT architects that take on server virtualization can draw models that reflect cost savings in a number of ways:

(i) Consolidation of servers into fewer machines results in lowering of power and cooling costs.

(ii) Reduce the data center footprint.

(iii) Reduce hardware vendor lock-in and server maintenance costs.

(iv) Faster server provisioning.

(v) Improve Disaster Recovery and isolate applications.

(vi) Software licensing savings.

The crucial backbone technology for cloud computing is virtualization. The following points are worth noting.

(i) The existence of cloud without virtualization although possible, would be very inefficient & difficult.

(ii) The idea of infinite availability, Pay for as much you use, & Pay as you grow require a very flexible & efficient back-end which is readily available in virtualized environments and machines.

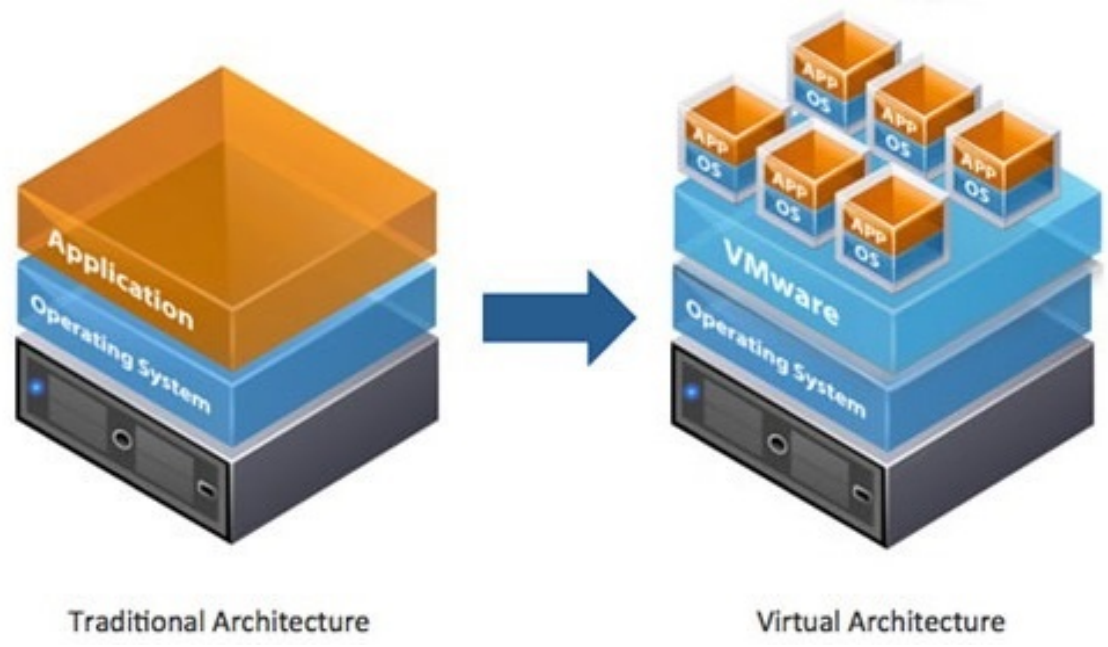


Figure 2.3: Virtualization Model

2.7 Types of virtualization

There are three types of virtualization technologies.

(i) **Full Virtualization**

Full virtualization provides a complete simulation of the underlying hardware while ensuring an isolated framework for various applications, which helps make this approach highly secure. The noncritical instructions are allowed to run directly on the hardware with full virtualization while critical instructions are discovered and substituted with traps into the VMM to be emulated by software.

(ii) **Partial Virtualization**

Partial virtualization provides a structure for sectional simulation of multiple instances of the underlying hardware environment, especially the address space. Address relocation hardware is essential for partial virtualization.

(iii) **Para Virtualization**

ParaVirtualization confers a software interface to virtual machines which is

similar to that of the underlying hardware. Para-virtualization techniques need to modify the guest OSs prior to code execution in order to manage the co-ordination between VMs & the physical hardware. A major advantage this approach presents is the absence of device driver requirement by the hypervisor.

2.8 Hypervisor in cloud computing

Virtualization involves a shift in operation from physical resource to logical, improves IT resource utilization by treating your physical resources as pool of resources where virtual resources will be dynamical allotted. This calls for a piece of software that allows abstraction of physical resources to the logical platform and is popularly known as hypervisor. Hypervisor creates multiple virtual servers within a single physical server.

Typically hypervisors are classified into two categories as shown in Fig. 2.4.

(i) **Type I Hypervisor**

A Type-1 or bare metal hypervisor is a client type hypervisor that interacts and runs directly on the hosts hardware that is being virtualized. It is entirely independent from the OS & boots before the operating system. Examples of this classic implementation of virtual machine architecture are VMWare ESX, Oracle VM, Microsoft Hyper-V and Xen.

(ii) **Type II Hypervisor**

A Type-2 or hosted hypervisor is a client type hypervisor that rests on an OS and relies heavily on it for provisioning of virtualization services such as I/O and memory management. This embedded hypervisor running at the third level cannot boot until the OS is up & running. Well known examples of such hypervisors are VMWare Workstation and Server, Microsoft Virtual PC, KVM, QEMU and Parallels.

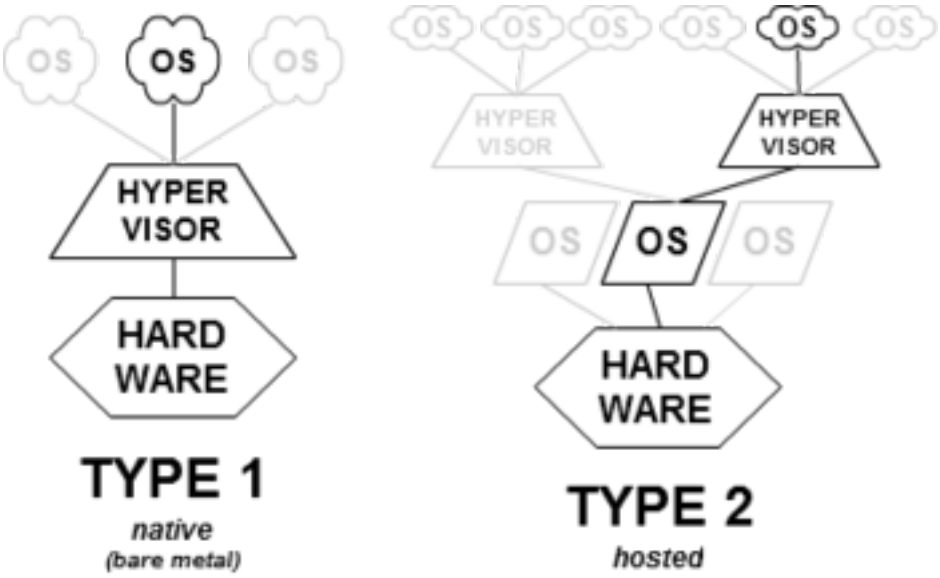


Figure 2.4: Types of hypervisor

Chapter 3

Private Cloud Server Side Architecture

3.1 Introduction

A conventional open-sourced cloud computing scheme, hosting virtual desktops as a platform-as-a-service cloud & applications as a software-as-a-service cloud is composed of many sections which need to work in concordance in a virtualized environment. The robust design of server and network infrastructure enables efficient sharing of resources across multiple nodes thus optimizing server utilization.

There exist certain legal, political, socio-organizational hurdles that might discourage an organization from using public cloud architecture for the reasons of confidentiality and security issues of private data. Hence, the private cloud solutions being more customizable and secure, are gaining widespread popularity.

3.1.1 The underlying physical hardware

It is essential that the hardware supports full virtualization using technologies such as AMD-V or Intel VT. IVT-enabled processors have additional instructions that can be used by the hypervisor to create and support VMs. Another important factor is that the 64 bit guest OS require 64 bit processor and BIOS compatibility with x64 virtualization. The minimum storage and memory requirements are as below:

(i) Processor: Intel(R) Core(TM) i5 CPU 650 @ 3.20GHz

(ii) Hard disk Capacity: 500 GB

(iii) RAM: 16 GB

3.1.2 The underlying Operating System

The operating system has to be a 64-bit Windows OS with the disk and RAM capacity specified.The OS used is Windows 7 professional SP1.

3.1.3 The Hypervisor

A hypervisor also called Virtual Machine Monitor(VMM) enables system consolidation and provides flexible design freedom for generating a virtual framework.

VMWare Workstation

VMWare workstation is a type II Virtual Machine Monitor that runs on x64 computers. It enables users to simultaneously use multiple virtual machines without disruption. It facilitates bridging existing host network adaptors and share physical disk drives with a virtual machine. The required hardware support is summarized below.

(i) x64 compatible CPU

(ii) 64 bit guest OS require 64 bit processor & BIOS compatible with x86 virtualization

(iii) Intel VT hardware technology

One remarkable feature of VMWare Workstation is VMWare tools. VMWare Tool is a package with drivers that is installed in guest OS to escalate their performance. The following are its important features.

(i) Drag & drop file support.

(ii) Time synchronization

(iii) Support for utility

(iv) Drivers for the emulated hardware.

3.1.4 The Cloud building Software

A Private Cloud is a highly scalable virtualised model where all components are allocated exclusively to a single customer, promoting stringent security, optimal performance & customisation in a private network. Open source software offers a solution to the vendor lock-in concerns many enterprises have with committing to a cloud platform. This hurdle is overcomed by private cloud as it provides the enterprises a collection of elastic, pooled resources that consumers of the cloud service can access through self-service mechanisms in an environment dedicated to your organization. The organizational benefits that flow from the cloud implementation include better control, optimized utilization, simplified infrastructure architecture and enterprise-wide management practices. Fig. 3.1 shows the important building blocks comprising the resilient private cloud infrastructure:

(i) Domain Controller

(ii) Openfiler

(iii) XenServer

(iv) XenCenter

(v) XenDesktop

(vi) XenApp

(vii) Citrix Receiver

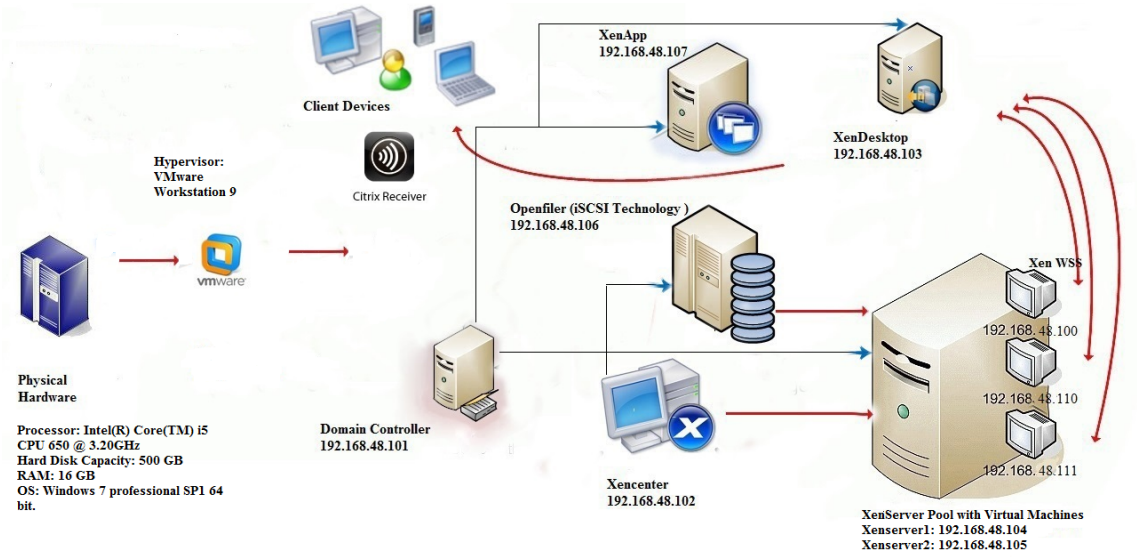


Figure 3.1: Private Cloud Infrastructure

3.2 Domain controller

A domain controller (DC) is a server that is responsible for managing security authentication requests (logging in, checking permissions, etc.) within the Windows Server domain. The server OS used is Windows Server 2008 R2 64 bit. It is built on Windows NT 6.1, which is the same kernel that was used with client oriented windows 7. It is the first 64 bit only server OS released from Microsoft. At any time, Directory Server Diagnosis can be run by typing "Dcdiag," from the command line to quickly evaluate the performance of a domain controller.

3.2.1 System Requirements

- Processor: A Single processor with 1.4 GHz (x64 processor) or 1.3 GHz (Dual Core)
- Memory: Minimum 512 MB RAM
- Disk Space Requirements: 32 GB or greater

Server Manager

Server Manager is a Microsoft Management Console snap-in that presents a consolidated view of the server. It provides a platform for server configuration, addition and removal of roles & features and reviewing their working status.

(i) **Server Roles**

A server role characterizes the prime function of the server. The server roles used are Active Directory Domain Services & DNS server.

(ii) **Server Features**

A feature describes the secondary or supporting function of a server. The server feature used is Microsoft .Net Framework 3.5.1 Features.

3.2.2 Active Directory Domain Services

ADDS forms the foundation for managing information about user identity, computers and other devices on the network & enables secure management of this information and facilitates resource sharing. An AD domain controller provides the functionality of authentication and authorization and accounting of all users & computers in a Windows domain type network assigning & imposing security policies for all computers.

Active Directory uses Lightweight Directory Access Protocol (LDAP) versions 2 and 3, Microsoft's version of Kerberos, & DNS. AD allows for the centralization of user & computer management, as well as usage & resource access.

Components of the Active Directory Logical Structure

Active Directory is a hierarchical database and accommodates the following components in its logical structure.

(i) **Organizational Units**

Organizational units are container objects that organize objects in a domain and delegate multiple levels of administrative authority and simplify management of commonly grouped resources by using Group Policy settings.

(ii) **Domains**

An Active Directory Domain is an administratively defined unit that shares a common directory database, security policies, and trust relationships with other domains.

(iii) **Domain Trees**

Domain trees are collections of domains that are clustered together in hierarchical formation.

(iv) **Forests**

The forest is a replication and a security boundary that contains a single instance of the directory schema.

(v) **Site Objects**

Within the scope of a forest, sites are a representation of the well connected portion of the network.

Active Directory Domain Services Installation

Active Directory Domain Services is installed using dcpromo.exe wizard. A new domain is created in a new forest. The Fully Qualified Domain Name (FQDN) of the new forest root domain is named as india.com. The forest functional level is chosen to be Windows Server 2008 R2. The first domain controller in the forest must be a global catalog.

Components of the Active Directory Users

Active Directory user authentication confirms the user identity and allows user access to resources (such as data, applications, or printers) located anywhere on the network as shown in Fig. 3.2. Active Directory user authorization secures resources from unauthorized ingress. Active Directory user objects include numerous attributes which post authentication and can potentially access an object, the type of access actually validated depends on user specific rights and control.

Figure 3.2: AD Users

3.2.3 Domain Name System

Domain Name System (DNS) is the primary name resolution service incorporated in a Windows Server 2008 network. Because domain names are alphabetic, they're easier to remember. A namespace is a grouping in which names are used to symbolically denote some other type of information, such as an IP address Typically, Windows Server 2008 DNS functions in conjunction with Active Directory Domain Services (ADDS). In this environment, DNS namespaces mirror the Active Directory forests and domains used by an organization as shown in Fig. 3.3. DNS architecture is a hierarchical distributed database & an associated set of protocols that define:

(i) A procedure for querying & updating the database.

(ii) A technique for replicating the information in the database among servers.

(iii) A schema of the database.

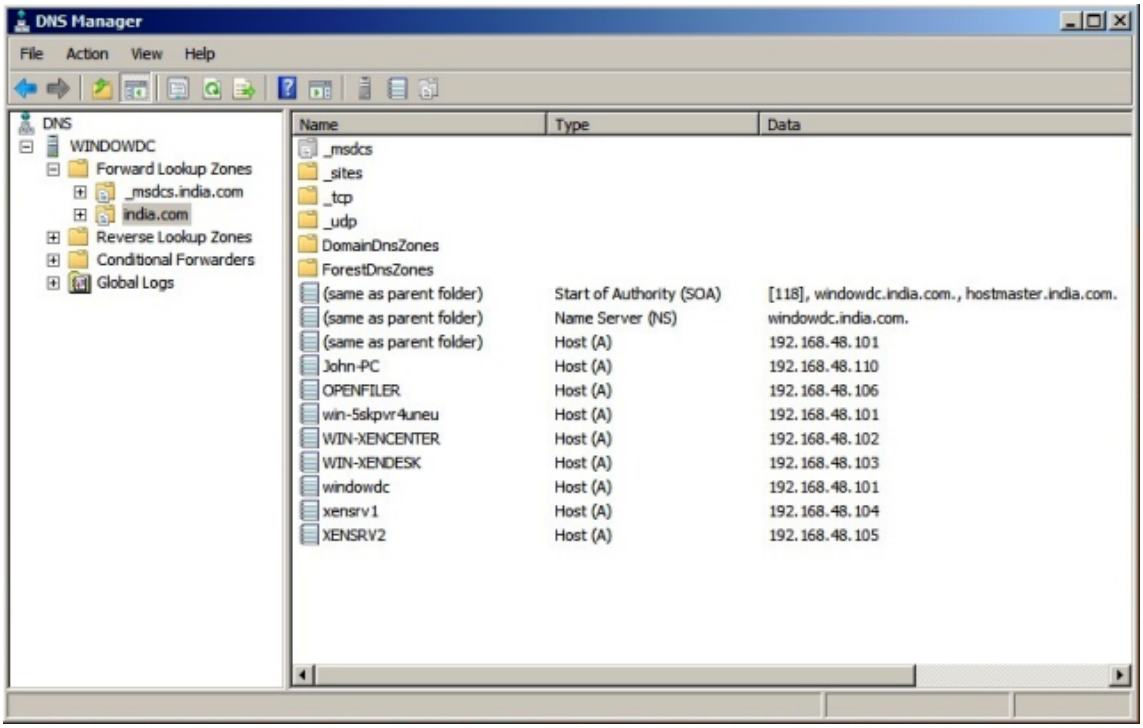


Figure 3.3: DNS Manager

3.2.4 Microsoft .Net Framework 3.5.1 Features

It combines the power of .Net Framework 3.5 APIs with new technology for developing applications that offers improved user interfaces performance, protects the computers' personal identity information, facilitates seamless and secure communication.

3.3 Openfiler

Openfiler is a Linux-based operating system that renders file-based network-attached storage & block-based storage area network. It is a free and conducive system that allows storage administrators to manage storage resources via a browser-based interface. Openfiler uses iSCSI storage technique to enable file accessing on cloud servers. Underneath the GUI interface, Openfiler is powered by a bunch of open-source software. At its core, it is an rPath OS with a 2.6 kernel, very similar

to Red Hat Linux. The Web-based admin console is driven by Python & lighttpd.

Because Openfiler uses Linux LVM, you easily can aggregate storage devices into a single pool and then slice that up as desired into whatever network share you want. Another benefit of using the Linux LVM is that point-in-time snapshots can be taken quickly and easily, allowing for consistent backups to be taken of the Openfiler appliance.

3.3.1 System Requirements

- CPU: A 64 bit processor with 1.6 GHz or higher.
- RAM: Minimum 256 MB of RAM, 2 GB recommended.
- Disk Space Space: 10 GB hard disk space (8 GB for OS installation and 2 GB for swap space), an optical drive (for local installation) and an Ethernet like network interface.

3.3.2 iSCSI Technology

Internet Small Computer System Interface is abbreviated as iSCSI, a technology that reaches out the Internet Protocol to SANs. iSCSI uses TCP as its transport protocol. The typically used TCP port for iSCSI traffic is 3260. The iSCSI protocol describes a means of universal access to storage devices by transportation of the SCSI packets over standard Ethernet-based TCP/IP, providing for an interoperable solution which can take advantage of existing Internet infrastructure. iSCSI allows transmission of data over LANs, WANs or the internet & enables location independent data storage & retrieval. Furthermore, iSCSI provides ease of scaling disk storage. With iSCSI, the disks are remote from the server,hence addition of a new disk only requires the use of disk manager.With no server downtime, iSCSI provides instant disk space using the initiator driver on the Windows machine, mapping the storage to the disk then allocating the desired disk capacity & formatting it under the disk manager. There are two types of devices in SCSI protocol.

(i) **iSCSI Initiators (clients)**

iSCSI Initiators function as an iSCSI client & requests commands be executed.

(ii) **iSCSI Targets (servers)**

iSCSI Targets refers to the storage resource located on an iSCSI server that carry out the commands received from the clients. The endpoint, within the target, that executes the command is known as a logical unit (LU). An individual target has the ability to interconnect with up to eight or more logical units using one controller.

The structure that communicates a command from an application client to a device server is known as a Command Descriptor Block (CDB).

iSCSI Naming and Addressing

The iSCSI protocol provides a methodology for naming & addressing of initiators and targets. iSCSI Qualified Name (IQN) is a unique name that identifies an iSCSI target adapter or an iSCSI initiator adapter as defined by the iSCSI standard. Fig. 3.4 shows a sample IQN number, as it might be displayed in XenCenter.

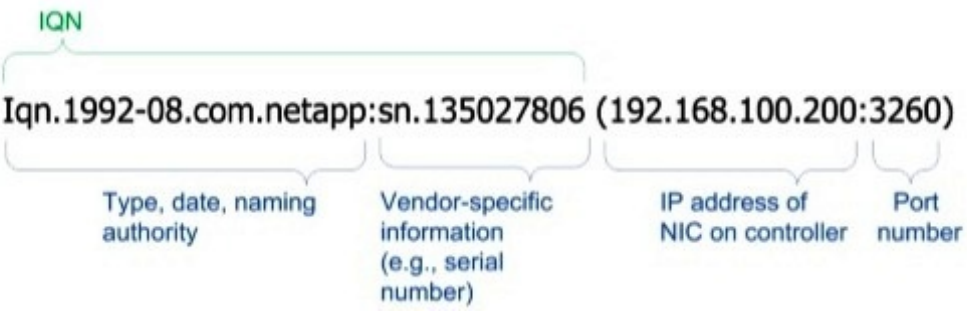


Figure 3.4: IQN

Due to the open nature of iSCSI, the same storage repository (SR) can be inherently shared by multiple XenServers in a resource pool. iSCSI-based SRs promote VM agility as VMs that are started on any host in a pool can be migrated between them. XenServer offers support for shared SRs on iSCSI LUNs (Logical Unit Number), using the open-iSCSI software iSCSI initiator.

3.3.3 Openfiler Installation and Configuration

Openfiler is installed as a virtual machine on the VMware workstation. The console view is shown in Fig. 3.5. Once the installation is complete, a SCSI hard disk is added to the virtual machine and stored as a single file with .vmdk extension with the disk space preallocated as shown in Fig. 3.6.

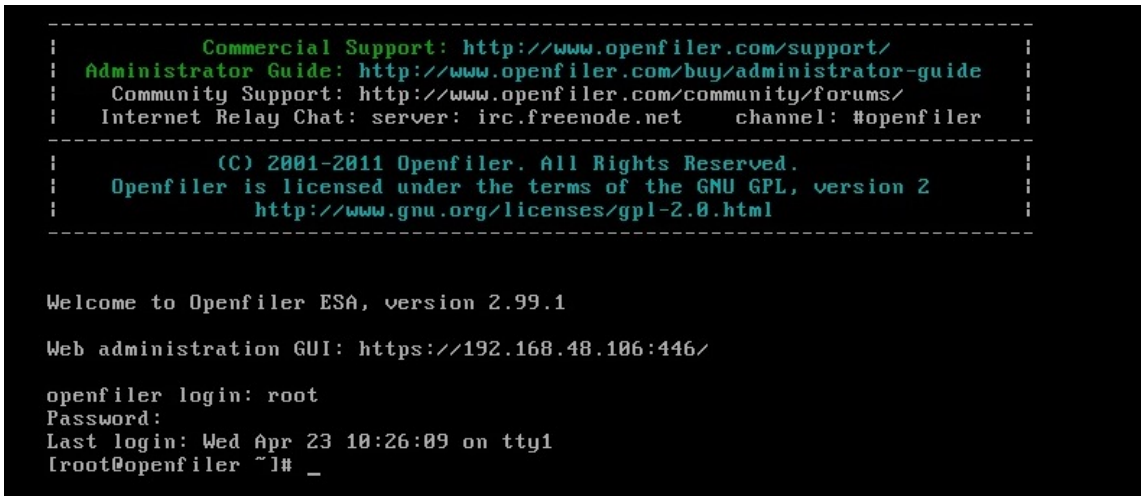


Figure 3.5: Openfiler Console

Openfiler login: root; Password: P@ssw0rd

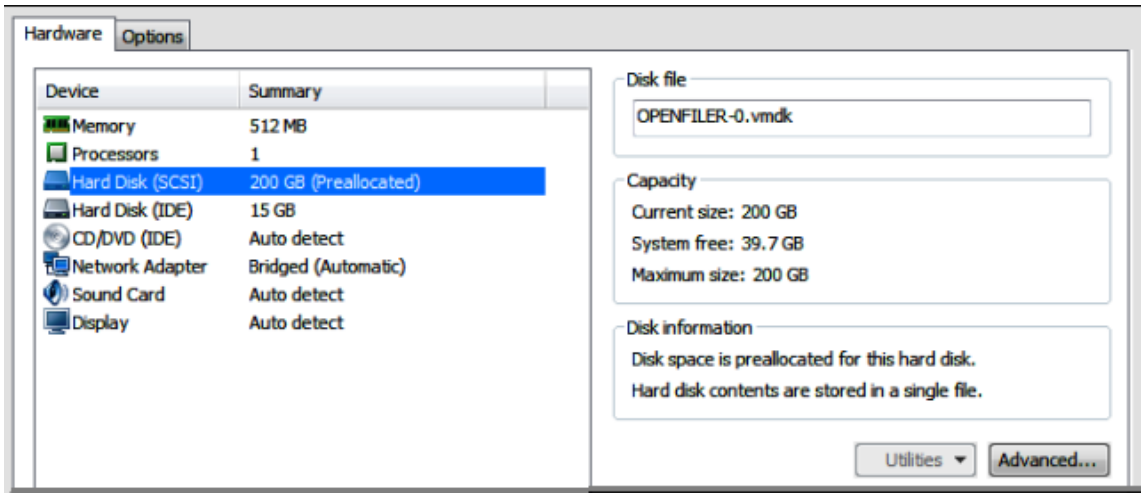


Figure 3.6: OPENFILER-0.vmdk

The next step that follows is to configure the Openfiler instance by directing a Web browser to https:// <ip of Openfiler host>:446. After logging in, we can configure various settings using the admin interface as shown in Fig. 3.7.

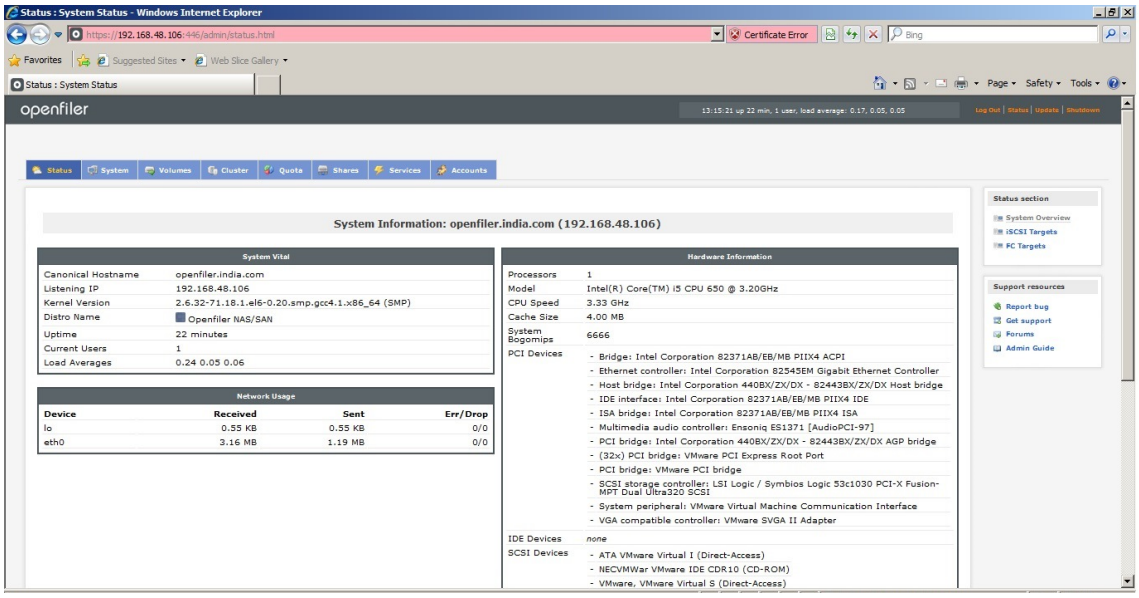


Figure 3.7: Openfiler GUI

Logical Volume Manager

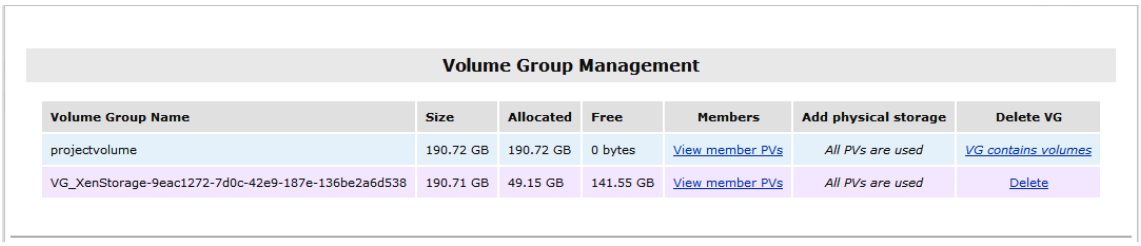
LVM is a tool that is used for logical volume management & provides flexibility in allocating disks, striping, mirroring & resizing the volumes. The volume manager assists in addition of disks to Openfiler, creation of filesystems & management of software RAIDs. By default, Openfiler creates the following partitions:

(i) /boot (101 MB)

(ii) swap (1020 MB)

(iii) The rest of the space is designated to main partition.

A project volume as shown in Fig. 3.8 is created from the virtual disk that was added to the VM as shown in Fig. 3.6.



Volume Group Management

Volume Group Name	Size	Allocated	Free	Members	Add physical storage	Delete VG
projectvolume	190.72 GB	190.72 GB	0 bytes	View member PVs	*All PVs are used*	*VG contains volumes*
VG_XenStorage-9eac1272-7d0c-42e9-187e-136be2a6d538	190.71 GB	49.15 GB	141.55 GB	View member PVs	*All PVs are used*	Delete

Figure 3.8: Volume Group Management

The block-based storage created is as shown in the Fig. 3.9. Linux uses block special files stored in the /dev/ directory. /sda and /sdb are the first and second SCSI disks.

Block Device Management

Edit Disk	Type	Description	Size	Label type	Partitions
/dev/sda	SCSI	ATA VMware Virtual I	15.00 GB	msdos	3 (view)
/dev/sdb	SCSI	VMware, VMware Virtual S	200.00 GB	gpt	1 (view)

Figure 3.9: Block Device Management

An iSCSI target as shown in Fig. 3.10 must be created for each volume before an iSCSI client can access the volume. Each iSCSI logical volume is mapped to a distinct iSCSI target & the associated network access permissions to that target are granted to the appropriate nodes.

Manage Services

Service	Boot Status	Modify Boot	Current Status	Start / Stop
iSCSI Target	Enabled	Disable	Running	Stop

Figure 3.10: iSCSI Traget

LUN Mapping

A logical unit number (LUN) identifies a unique and discrete configured set of disks that is presentable to a host & mounted as a volume within the OS. The storage subsystems have their physical disks partitioned into logically addressed portions called logical units which are identified by a specific LUN. LUNs address up to seven devices at each SCSI ID on an 8-bit bus or up to 15 devices at each ID on a 16-bit bus.

LUNs represent a logical abstraction layer between the physical disk device & the applications. LUN mapping is the technique that creates a disk resource & defines its external access paths.Once the new iSCSI target is created, the step that follows is mapping the suitable iSCSI logical volumes to it. The correct iSCSI target selection is verified under the Target Configuration sub-tab. Then, the appropriate iSCSI logical volume is mapped to the target by clicking Map as shown in Fig. 3.11. iSCSI virtual disk storage is configured to be used.

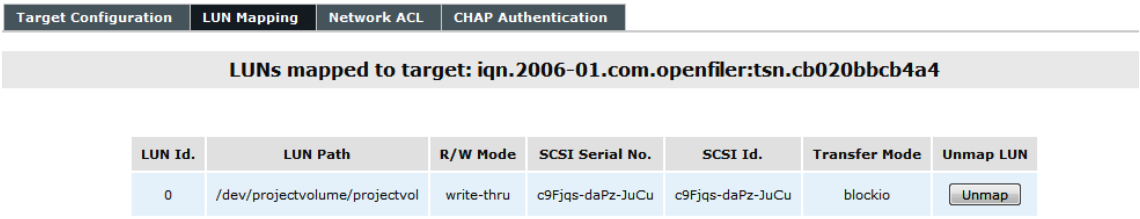


Figure 3.11: LUN Mapping

UUID

A UUID (Universal Unique Identifier) is a 128-bit number that uniquely identifies an object or entity on the Internet. UUID uniquely identifies the metadata header at the start of every physical volume managed by the volume manager.

3.4 XenServer

Citrix Xenserver is a dynamic workload delivery platform from citrix. The XenServer package accounts for creation and management of deployable virtual x86 computers running on Xen. Xen is an open-source paravirtualizing hypervisor that is implemented as a thin layer of software residing between the bare metal hardware and the virtualized operating systems. It runs guests in environments known as domains which envelope a complete running virtual environment.

XenServer leverages the native storage capabilities more directly. For example, with block-based storage such as iSCSI or Fiber Channel SANs, XenServer extends VHD with the Logical Volume Manager (LVM) standard for volume management while with a file-based shared storage system such as NFS, XenServer VMs are stored directly using Microsoft Virtual Hard Disk (VHD) format. Fig. 3.12 shows XenServer Console view.

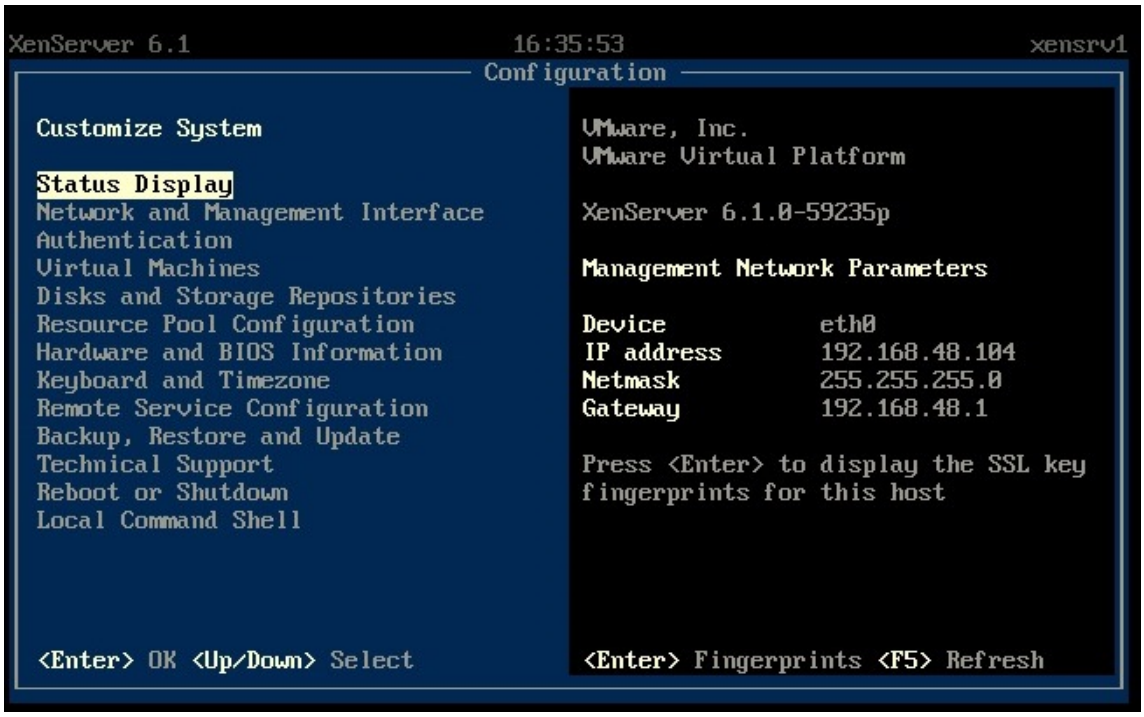


Figure 3.12: XenServer Console View

3.4.1 System Requirements

- CPU: A 64-bit x86 CPU, minimum 1.5 GHz , 2 GHz or faster multicore CPU recommended
- RAM: Minimum 2 GB, 4 GB or more recommended
- Disk Space: A Locally attached storage (PATA, SATA, SCSI) with minimum 16 GB of disk space, 60 GB of disk space recommended.

3.4.2 Xenserver Architecture

The foundation of XenServer is based upon powerful open-sourced Project Xen Hypervisor. Xen is the only open source type-1 hypervisor available. The Xen hypervisor is a thin layer of software which emulates a computer architecture allowing multiple operating systems to run simultaneously. There are two types of Domains:

(i) **The Control Domain (Dom0)**

Domain 0 is a special driver domain containing the management interface & drivers for administration. Domain 0 is a 32-bit CentOS VM that holds a control stack that administers VM creation, configuration, & destruction. Dom0 is capable of accessing the hardware directly, administering all access to the systems I/O functions and interacting with other Virtual Machines. It also reveals a control interface to the external world for efficient supervision of guest VMs.

All VM interactions with the hardware are managed through this priveleged domain, which runs on top of the hypervisor. The XenServer Domain 0 is shown in the upper-left-hand side of Fig. 3.13 & runs an optimized instance of Linux. This architecture circumvents the requirement of a discrete database server for the core management functions. The CPU usage in dom0 is monitored based on the volume of packets passing through dom0. Dom0 has a number of abilities including:

(a) Boots first & automatically with the hypervisor.

(b) Has elevated privileges

(c) Provides device drivers

(d) Provides mechanism to configure Virtual environment.

(ii) **The guest domain (DomU)**

A domain or guest is a running instance of a virtual machine. U stands for unprivileged. Guest OS runs in this domain.

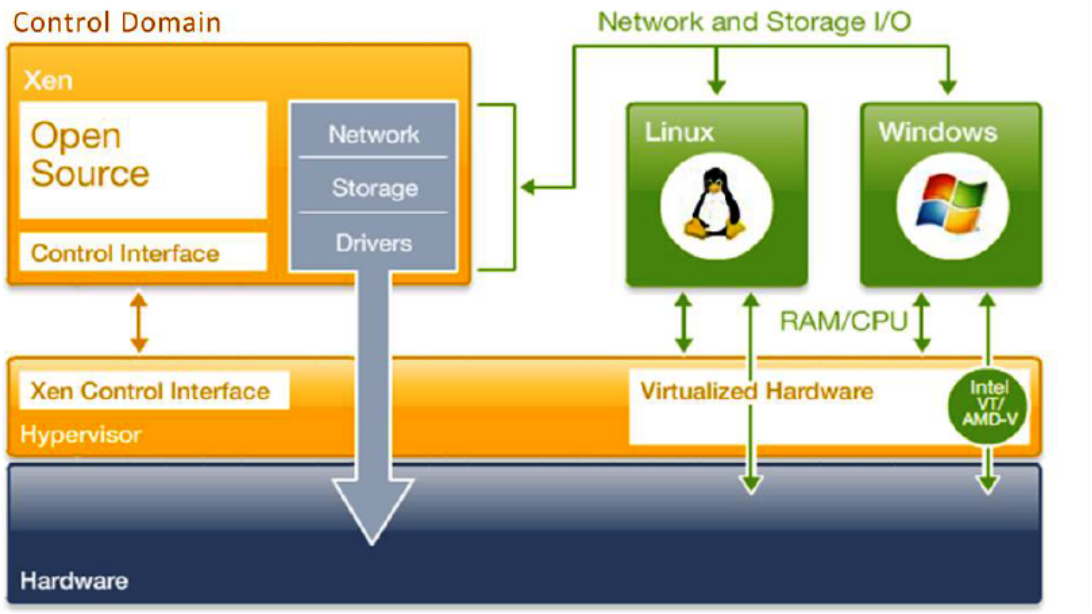


Figure 3.13: XenServer Architecture

3.4.3 Xenserver Resource Pool Configuration

A Citrix XenServer pool is a group of XenServer hosts & allows you to view multiple servers as a single resource, authorizing flexible deployment of virtual machines based on the resource requirements & business priorities. Citrix XenServer pools allow us to view several servers and their connected shared storage as a single unified resource. Typically, resource pool members are of types.

(i) **Master pool member**

One server in the pool is designated as the pool master, and provides a single

point of contact for all of the servers in the pool, routing communication to other members of the pool as necessary. It maintains pool configuration data & manages distributed locking for shared storage.

(ii) **Secondary pool member**
It is controlled through the master & maintains pool configuration backup & can be promoted to pool master in case of outage.

Pool Requirements (Hardware Prerequisites)

All the servers in the XenServer resource pool must have broadly compatible CPUs.

(i) The CPU vendor (Intel, AMD) must be the same on all CPUs on all servers. In particular Intel VT CPUs and AMD-V cannot be mixed.

(ii) The CPUs must have the same feature set. To allow servers with non-identical CPUs to be members of the same pool, CPU masking can be used to hide incompatible features.

(iii) All CPUs must have virtualization enabled.

Pool Requirements (Software Prerequisites)

In addition, to the hardware prerequisites identified above, there are a number of other configuration prerequisites for a server joining a pool. The XenServers joining the pool must have:

(i) A static IP address. The servers providing shared iSCSI storage must also possess static IP address.

(ii) System clock must be synchronized to the pool master (for example, via NTP).

(iii) Should run the same version of XenServer software, at the same patch level, with same supplement packs & with same product license edition as the servers already in the pool.

(iv) Should not have any active operations in progress on its VMs.

3.4.4 Xenserver Administration

XenServer can be administered by means of the following:

(i) **XenCenter**

XenCenter is a Windows-based graphical user interface.

(ii) **XenServer Command-line Interface (CLI)**

Linux-based xe commands can be used to administer XenServer.

3.5 XenCenter

Citrix XenCenter is the graphical, Windows-based user interface that manages & monitors XenServer hosts & resource pools. XenCenter allows users to create, deploy, manage, & monitor Virtual Machines (VMs) from Windows desktop machines without the need for a separate database. Xencenter encourages easy deployment, management & monitoring of VMs along with extensive configuration tools such as workload balancing, role based access control, system performance monitoring, dynamic memory sharing, high availability, VM protection & recovery.

3.5.1 System Requirements

- Operating System: All editions & versions of Windows XP, Windows Vista, Windows 7, Windows Server 2003, Windows Server 2008 & Windows Server 2008 R2
- RAM: Minimum 1 GB, 2 GB or more recommended

3.5.2 XenCenter Roles and Features

The following roles and features are added using the add roles & add features wizard in the server manager:

(i) **Roles**

(a) Web Server IIS

(b) Windows Process Activation Service

(ii) **Features**

(a) .Net Framework 3.5.1 Features

3.5.3 Xencenter Installation and Configuration

Xencenter is installed on Windows server 2008 R2 x64 Enterprise Edition OS & joined to the domain. The configuration steps are:

(i) **Creation of Resource Pool**

A new resource pool is created as shown in Fig. 3.14 & the XenServers are added, one of them is configured as the master server.

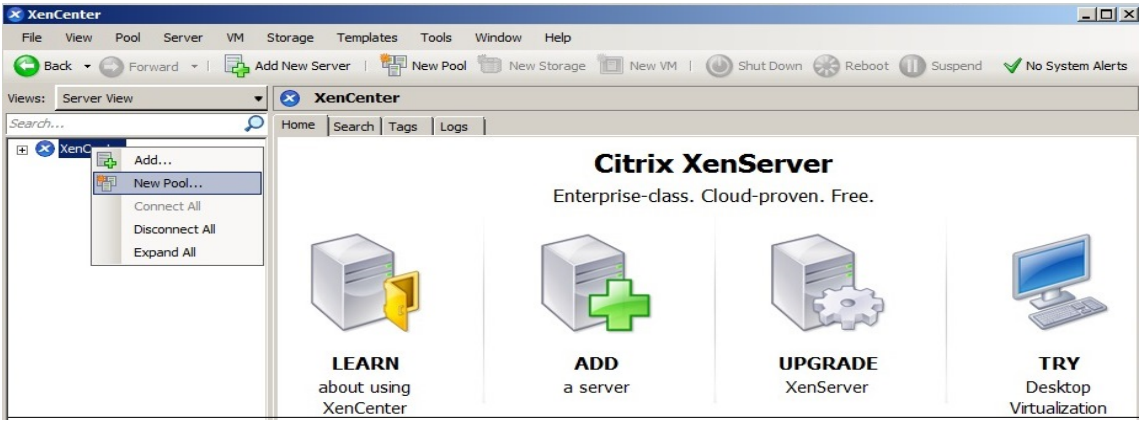


Figure 3.14: Creation of Resource Pool

(ii) **Creating the Storage Repository**

The advantages of pools (for example, running a VM on the most appropriate server and VM migration between servers) are only available if the pool has one or more shared storage repositories (SRs). The value returned as the Target IQN displayed in XenCenter also includes the IP address of the NIC on the controller and the port number the host & array use for communication.

(iii) **Addition of servers to the Resource pool**

A pool may contain up to 16 XenServers. Two servers xensrv1 & xensrv 2 are added to the Xenpool as shown in Fig. 3.15.

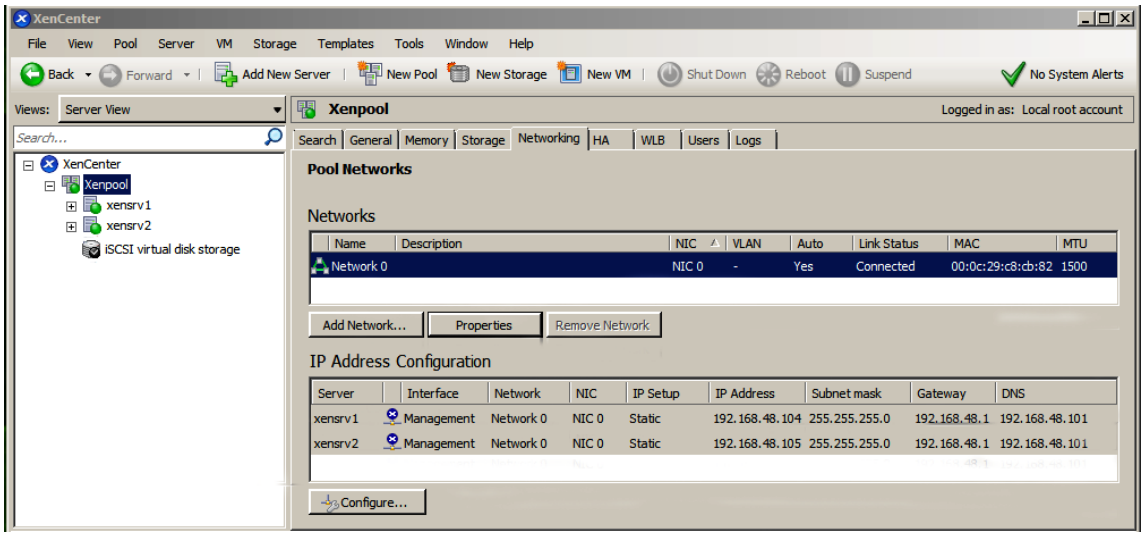


Figure 3.15: Server View in XenCenter

(iv) **Join Servers to domain and add active directory users**

Active Directory users created in domain controller are added to the Xenpool in the Xencenter console as shown in Fig. 3.16.

Figure 3.16: AD Users

(v) **VM Creation**

All guest virtual machines hosted in Dom U of XenServer are crested using XenCenter user interface. A right-click on the XenServer Resource pool in the server view opens a New VM wizard as shown in Fig. 3.17. A wide range of templates can be chosen from. The steps following include naming the VM, providing the installation media, choosing the home server from the resource pool, allocating CPU, memory and iSCSI storage space and networking for the VM.

A home server is the server which provides the resources for a VM in a pool. XenServer always attempts to start up the VM on that server if it can; if unavailable, then an alternate server within the same pool is selected automatically. Virtual machines are installed on the server according to user demands. The deployable VM is as shown in Fig. 3.18. A VM running on XenServer is shown in Fig. 3.19.

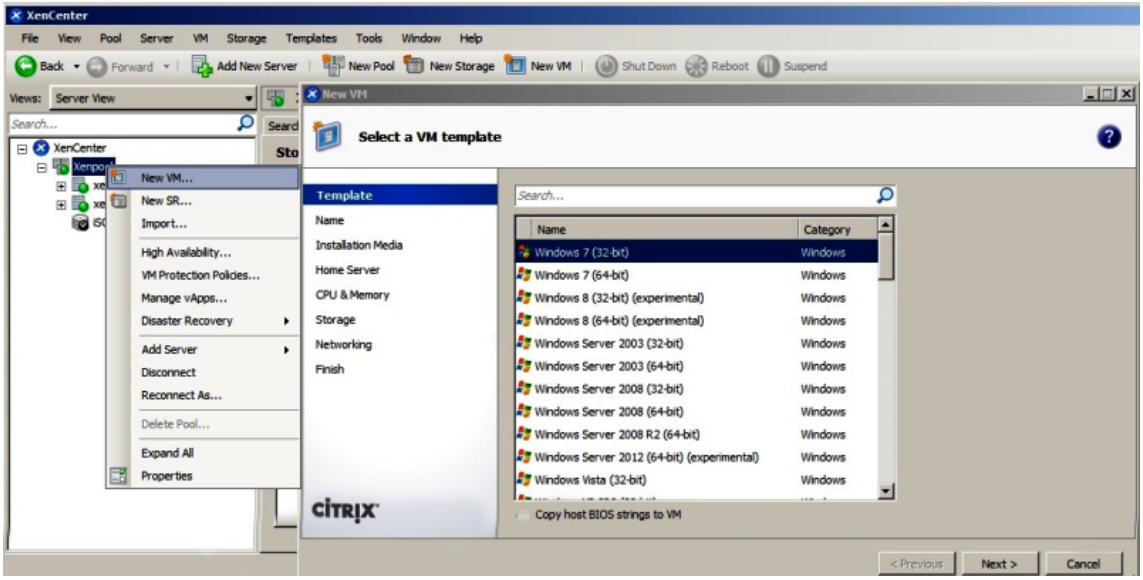


Figure 3.17: New VM Wizard

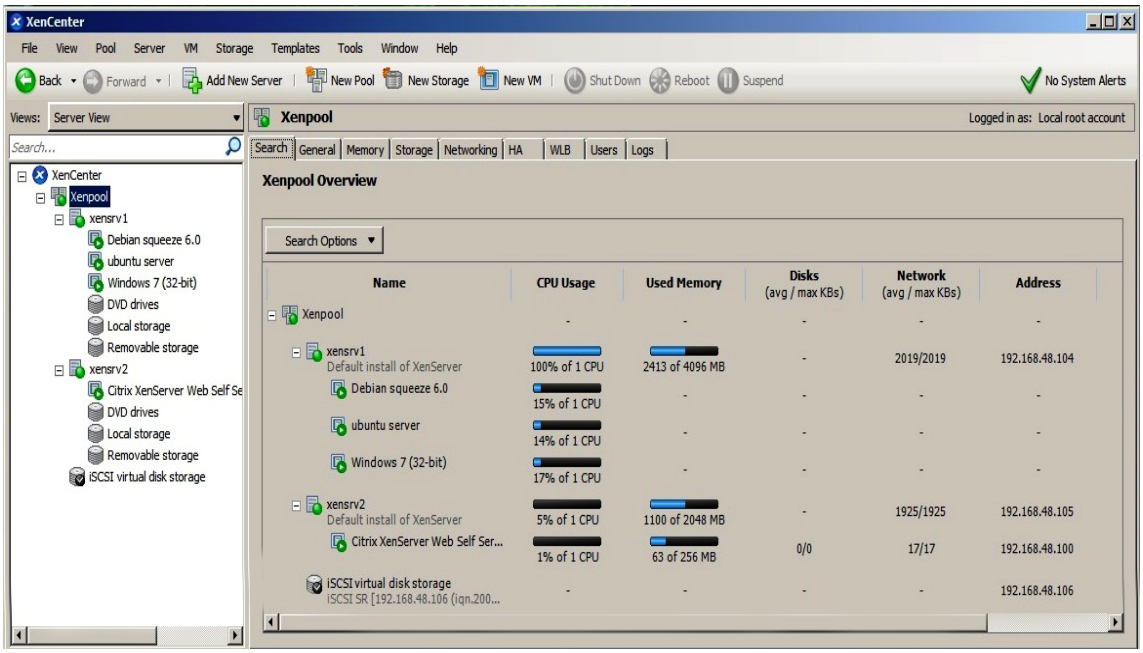


Figure 3.18: Deploy ready virtual machines in XenCenter

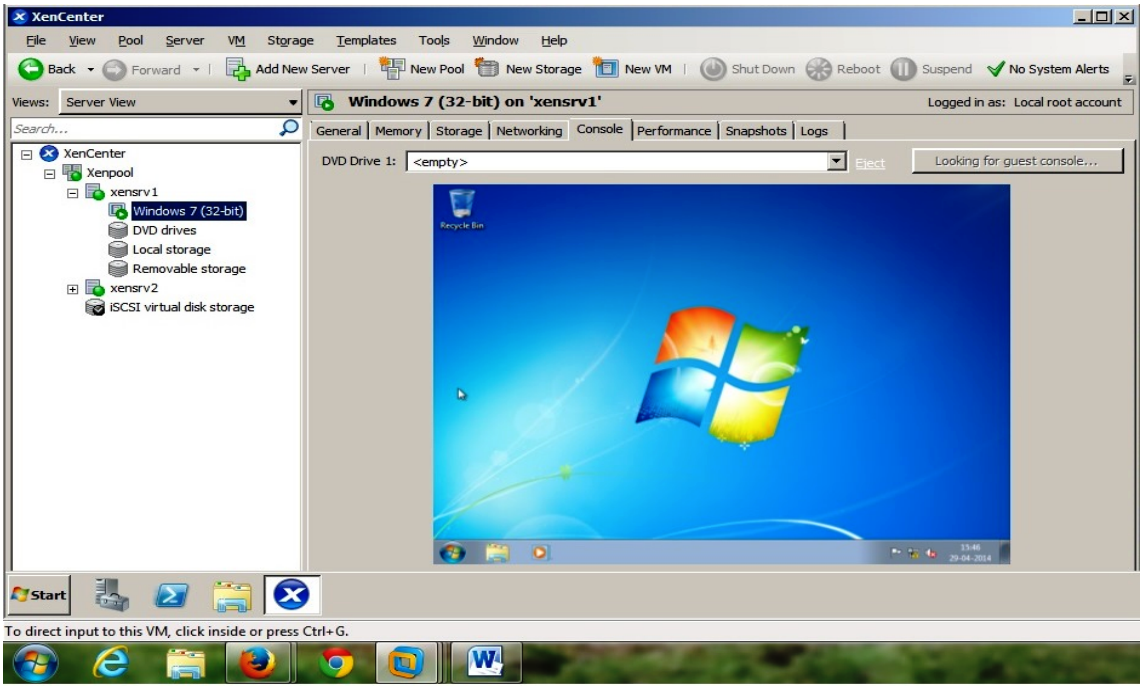


Figure 3.19: Win 7 Console View

(vi) **Xen Web Self Service**

XenServer WSS is a Web based virtual machine management console. The system requirements for Xen WSS are:

(a) XenServer Versions: 5.6, 5.6 FP1, 5.6 SP2, 6.0, 6.1

(b) RAM (minimum): 256 MB

(c) Disk Space (minimum): 1 GB

(d) Network: Routable access to the XenServer Pool.

(e) Browser(Installed with JRE version 1.6.0 and above): IE 8 & above; Firefox 5 & above; Chrome 13 & above.

It enables Citrix XenServer administrators to:

(a) Assigns access to individual VM guests to end-users for remote usage.

(b) View consolidated virtual machine guests from multiple resource pools.

(c) Perform basic life cycle operations such as Start, Stop, Suspend, and Reset on virtual machine guests.

Xen Web Self Service is imported as an .xva file as shown in Fig. 3.20.

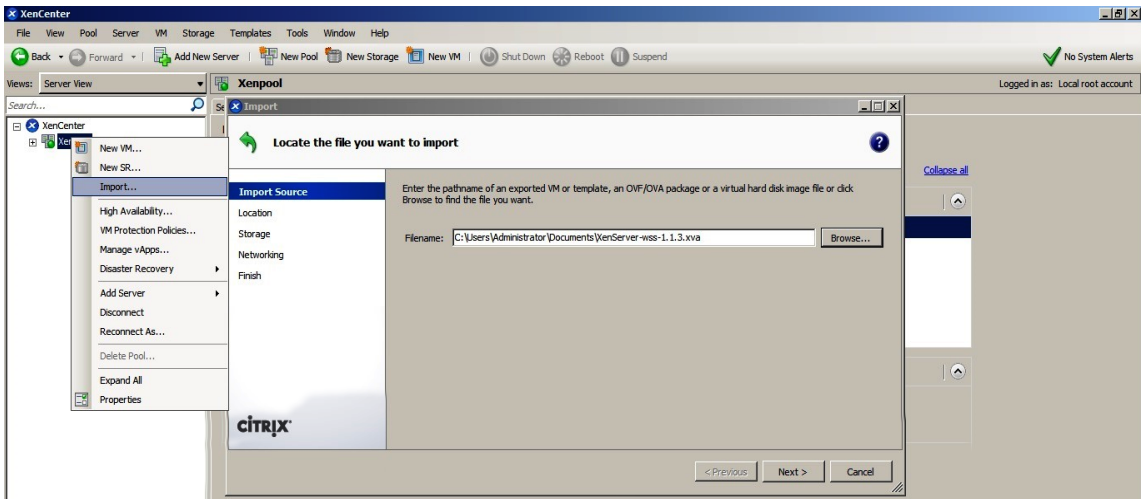


Figure 3.20: WSS Import

On successful start-up, it generates a web URL as shown in Fig. 3.21.

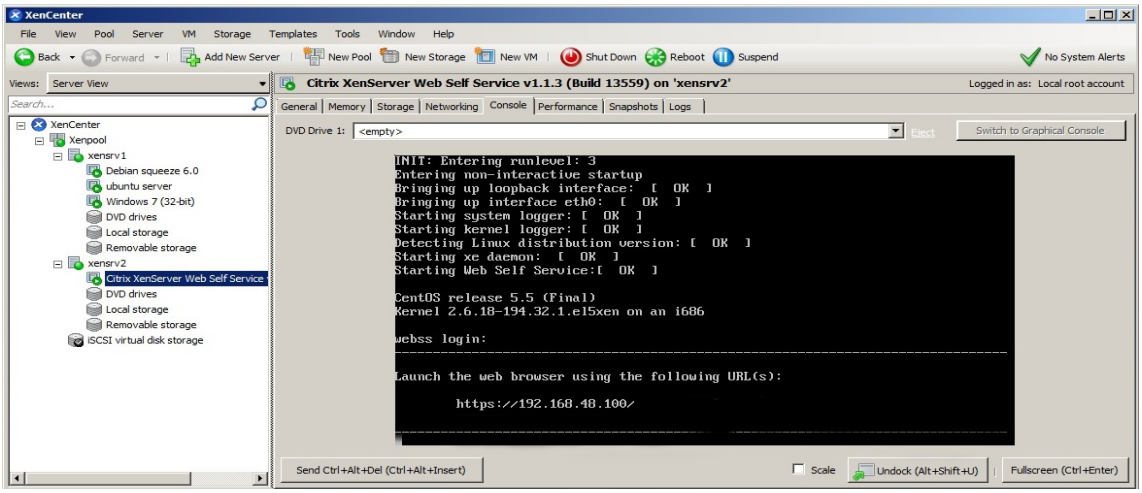


Figure 3.21: Citrix XenServer Web Self Service

The virtual appliance uses DHCP to obtain the IP address. However WSS can be configured to use static IP address by running the following commands to edit the network configuration file as shown in Fig. 3.22.

cd /etc/sysconfig/network-scripts/ (Change directory)

vi ifcfg-eth0 (Open the file named ifcfg-eth0 in vi editor)

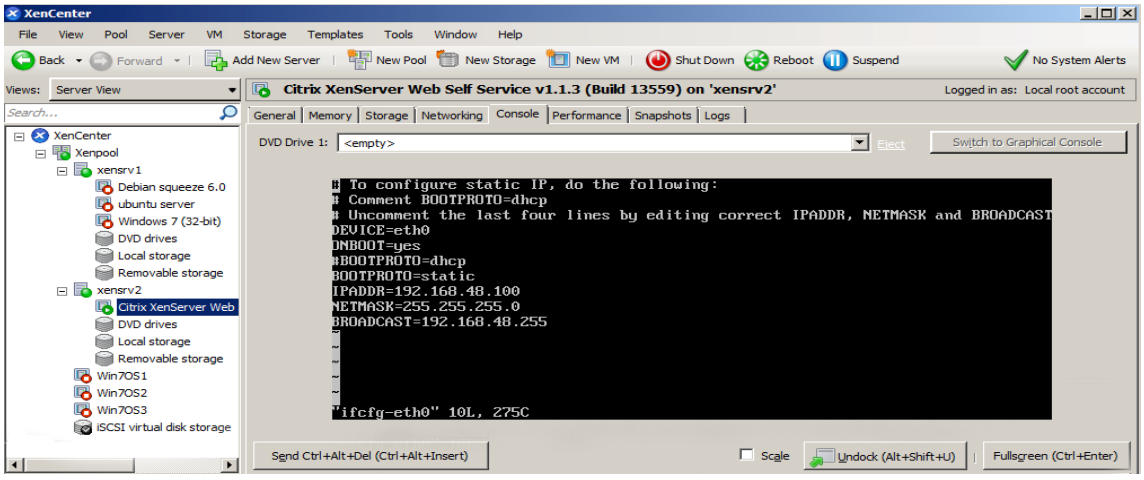


Figure 3.22: Configuring a static IP Address for WSS

The console needs to be rebooted after saving the changes. User authentication is done through active directory (via XenServer). The final configuration steps are carried out by the administrator before user access by pointing to the URL https://<ip address of Xen WSS>/.

The three steps to complete the setup follow in the web console as shown in Fig. 3.23. Post the configuration of web console, the users of this service would be able to remotely login & access the virtual environment using the given authorized id over the browser.

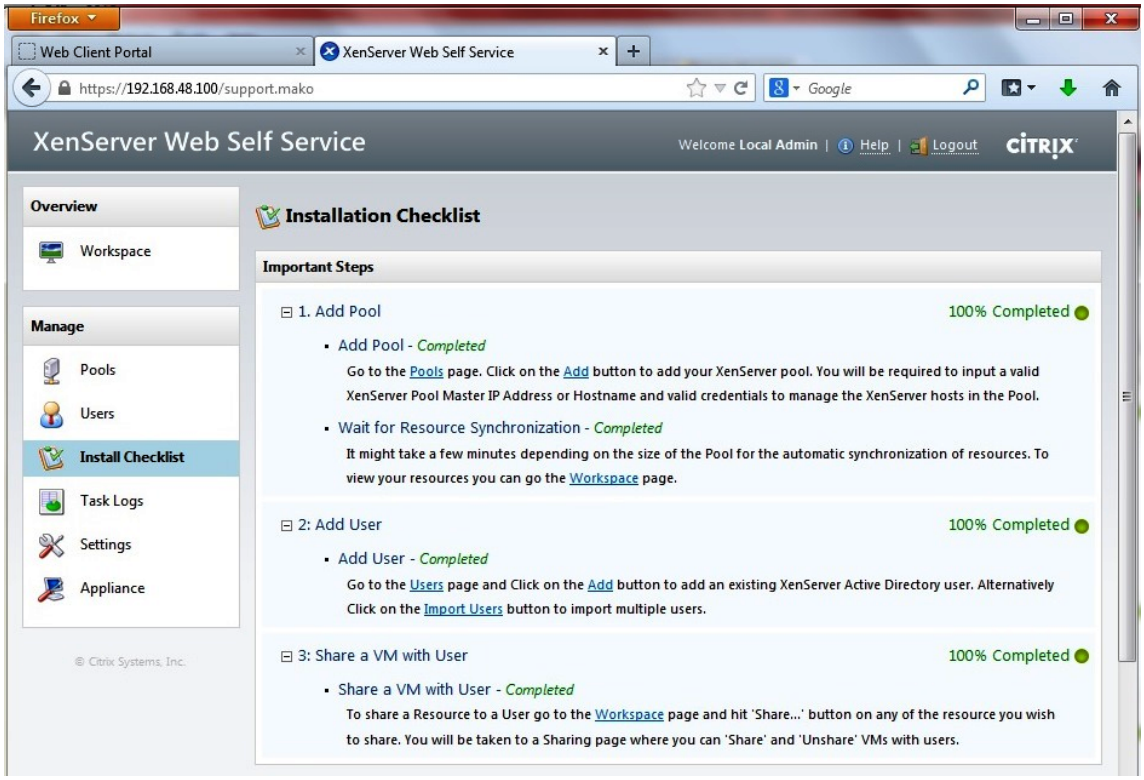


Figure 3.23: WSS Installation Checklist

3.6 XenDesktop

XenDesktop is a desktop virtualization system that is responsible for centralization & delivery of desktops to users. It reduces desktop cost of ownership by 40 percent & improves data security by consolidating desktop management. XenDesktop provides a high definition user experience and personalized desktops to users over any connection. It delivers Microsoft Windows virtual desktops as a remotely available service to users. End user's device is required to have capability of running Desktop Receiver software.

3.6.1 System Requirements

- Operating System: All editions & versions of Windows XP, Windows Vista, Windows 7, Windows Server 2003, Windows Server 2008 & Windows Server 2008 R2
- RAM: Minimum 1 GB, 2 GB or more recommended

3.6.2 XenDesktop Roles and Features

The following roles & features are added using the add roles & add features wizard in the server manager:

(i) **Roles**

(a) Web Server IIS

(b) Application Server

(c) Remote Desktop Services (formerly Terminal Services)

(ii) **Features**

(a) .Net Framework 3.5.1 Features

(b) Remote Assistance

(c) Remote Server Administration

(d) Windows Process Activation Service

ICA & CGP use TCP ports 1494 & 2598 which are supposed to be open at the firewalls to enable users outside the data centre to access them.

3.6.3 XenDesktop Architecture

Fig. 3.24 shows a complete virtual desktop delivery system formed by amalgamation of multiple distributed components with advanced configuration tools that simplify the creation & management of the virtual desktop infrastructure.

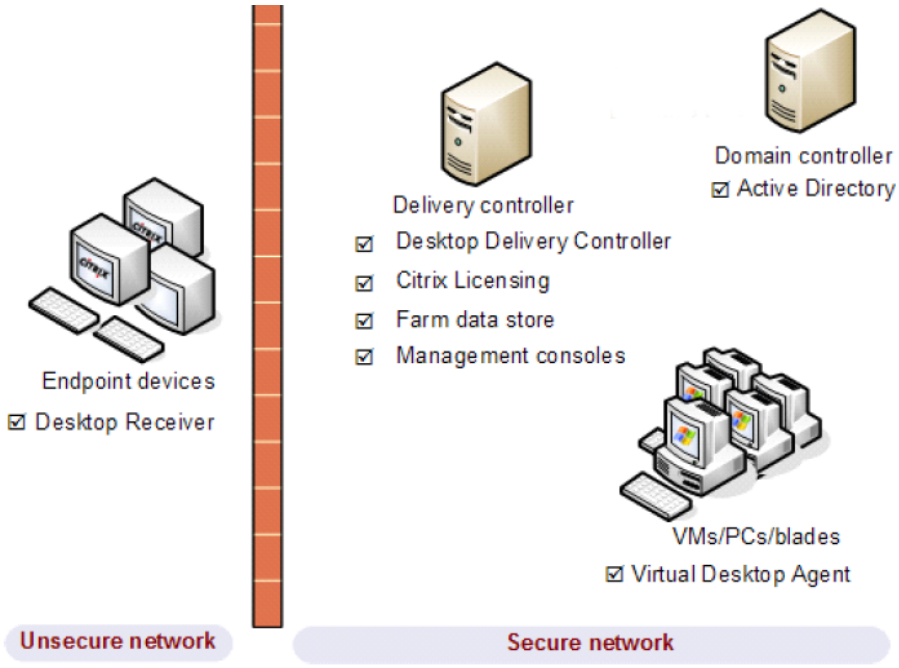


Figure 3.24: XenDesktop Architecture

The essential elements needed for the proper working of a XenDesktop farm are:

(i) **Xenserver**

(ii) **Delivery Controller**

(a) Desktop Delivery controller

The controller is the core technology consisting of services that

authenticates users, manages the assembly of users' virtual desktop environments, and bridges connections between users & their virtual desktops. It is to be noted that DDC brokers the connection but once eastablished, the connected sessions act independently.

(b) Citrix Licensing
It is installed by default when Desktop Delivery Controller is installed.

(c) Farm data store
It is where configuration information & administrator account information, is stored.

(d) Management consoles
It enables creation of desktop groups & deployment management.

(iii) **Virtual Desktop Agent**
It is installed on virtual desktops; the agent enables direct ICA (Independent Computing Architecture) connections between the virtual desktop & user devices.

(iv) **Citrix online plug-in**
The Citrix online plug-in enables direct ICA connections from user devices to virtual desktops.

The peculiar benefit of a VDI product such as XenDesktop is that it centralizes the control of client desktops & simplifies migration to new desktop OSs. Centralized control minimizes the number of client desktop images that is required to manage & patch as well as centralizes their location in the data center.

3.6.4 XenDesktop Installation and Configuration

XenDesktop is installed on a Windows Server 2008 R2 machine with the required roles and features configure as shown in Fig.3.25. XenDesktop presents desktops and applications to client devices through Catalogs. XenDesktop includes components designed to broker connections between clients and catalogs, to manage provisioning, and to maintain images of desktops and applications.

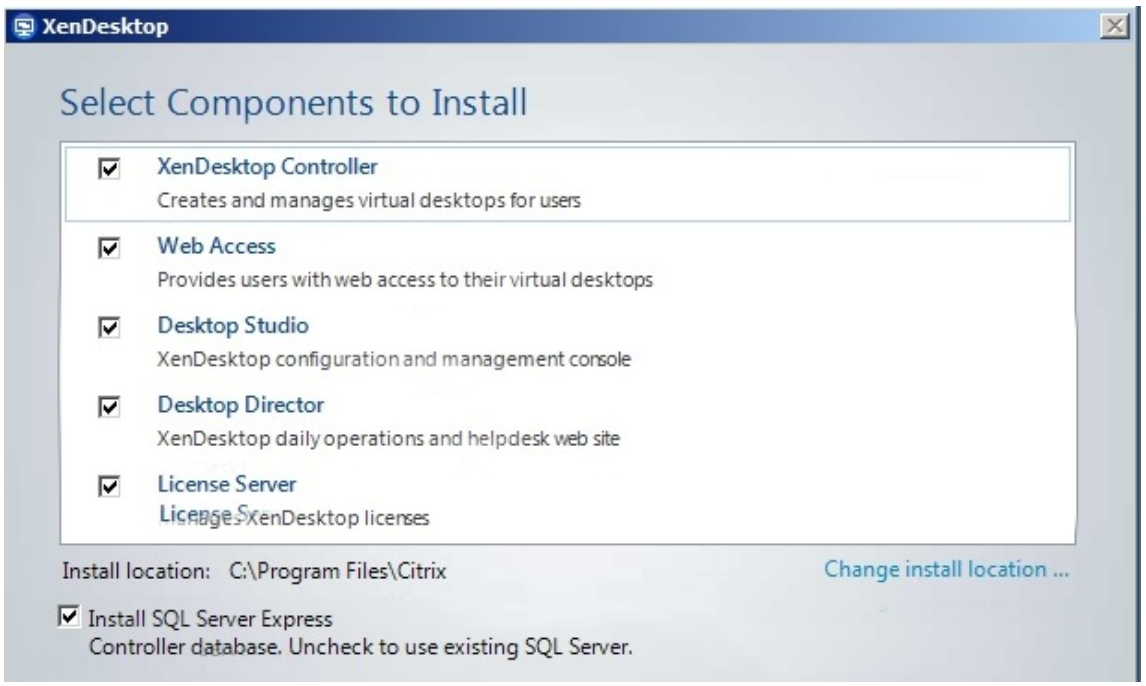


Figure 3.25: XenDesktop Components

XenDesktop Studio

It enables configuration and management of the XenDesktop deployment. It provides various wizards for creation and assignment of desktops to users. Desktop Studio offers quick to advanced configuration options for machine deployment as shown in Fig. 3.26.

Figure 3.26: XenDesktop Studio

In Desktop Deployment wizard, the domain site along with license server information is provided. Microsoft SQL Server 2008 R2 SP2 Express Edition is used as the database server. The steps that follow include configuring the host type

that will host the VMs to be deployed along with the iSCSI storage as shown in Fig. 3.27. Fig. 3.28 shows the desktop deployment summary.

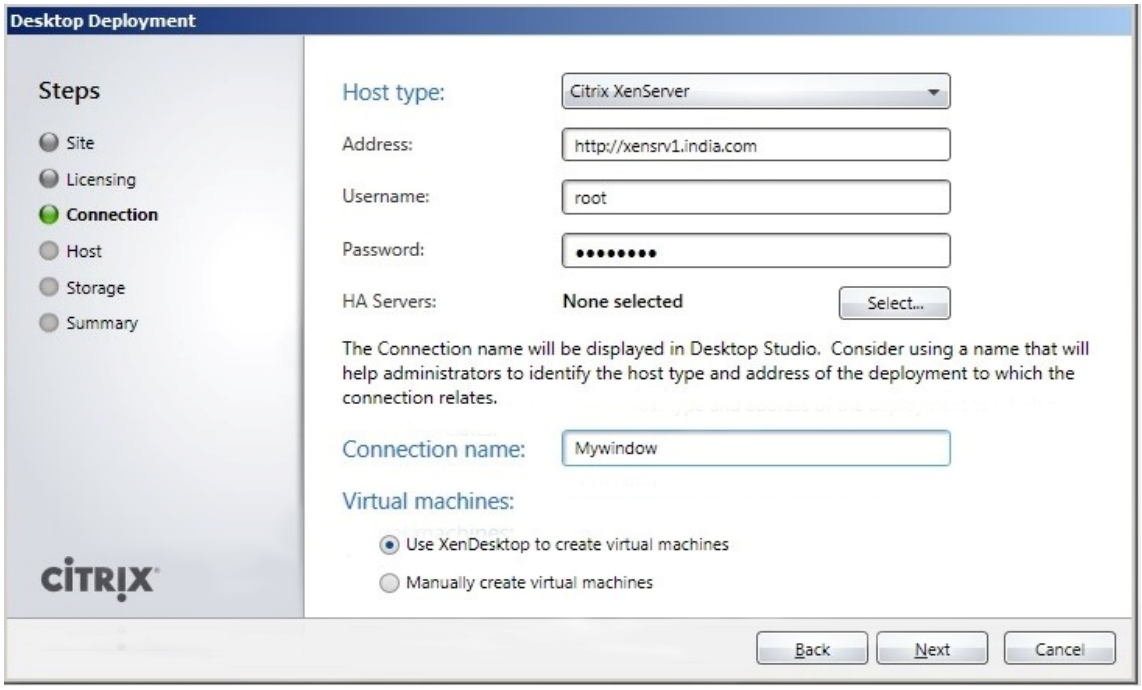


Figure 3.27: Desktop Deployment

Active Directory Service with Desktop Delivery Controller

All the computers in a farm are supposed to be members of the same domain, or of mutually trusting domains in a single Active Directory forest for proper functioning of desktop controller. Desktop Delivery Controller uses Active Directory for two main purposes:

(a) Active Directory's integral safety infrastructure is used by desktops to verify whether the incoming communication is from an authorized controller originating from the appropriate farm.

(b) Active Directory equips desktops to discover the controllers that constitute a farm. Thus, the addition of a new controller to the farm does not require reconfiguration of all the desktops in the farm.

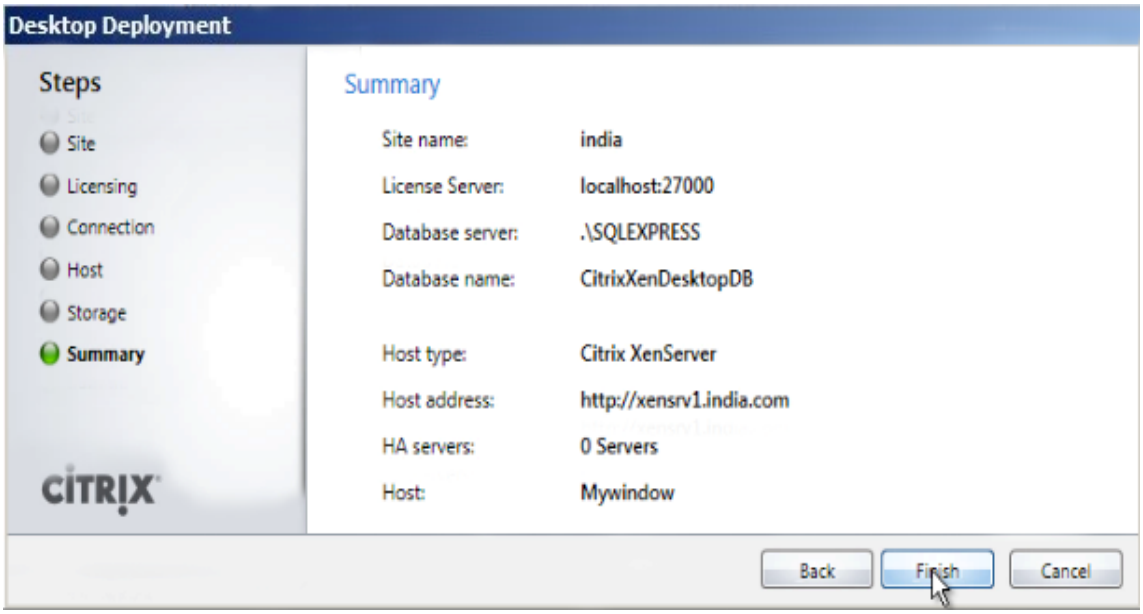


Figure 3.28: Desktop Deployment Summary

3.6.5 VM Configuration

The desktop-side component of XenDesktop, known collectively as the Virtual Desktop Agent is installed on the master Virtual machine running on XenServer (hypervisor) as shown in Fig. 3.29. Advanced install option is chosen in VDA installation wizard.

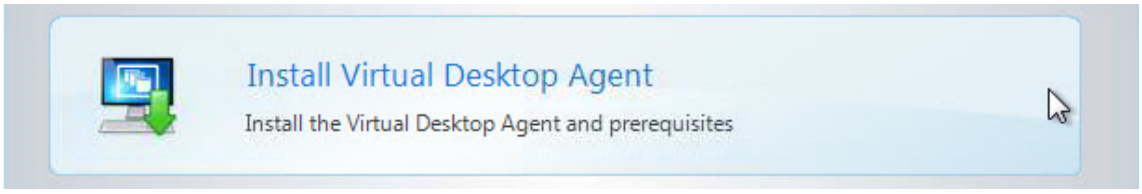


Figure 3.29: Virtual Desktop Agent Installation

Personal vDisk, a personalization solution for virtual desktops is enabled in the successive steps as shown in Fig. 3.30.

The next step involves connection of VDA to the XenDesktop Controller using the site name as the XenDesktop controller is registered to the Active Directory. The VDA configuration is as shown below in Fig. 3.31.

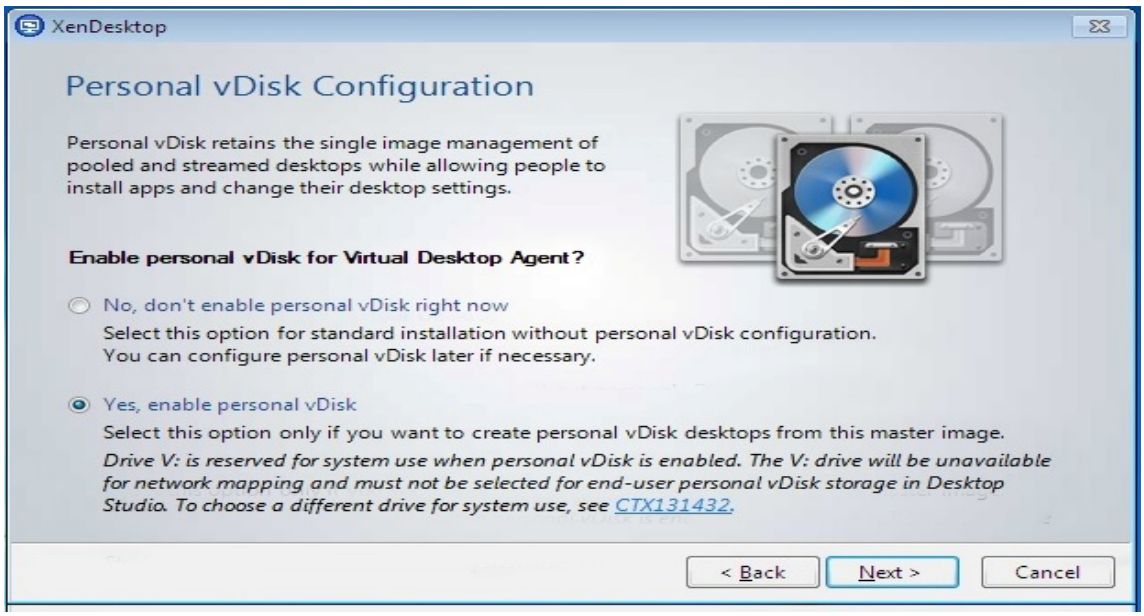


Figure 3.30: Personal vDisk Configuration

This completes the VM configuration and is ready to be used by Machine Creation Service as master image for VM deployment.

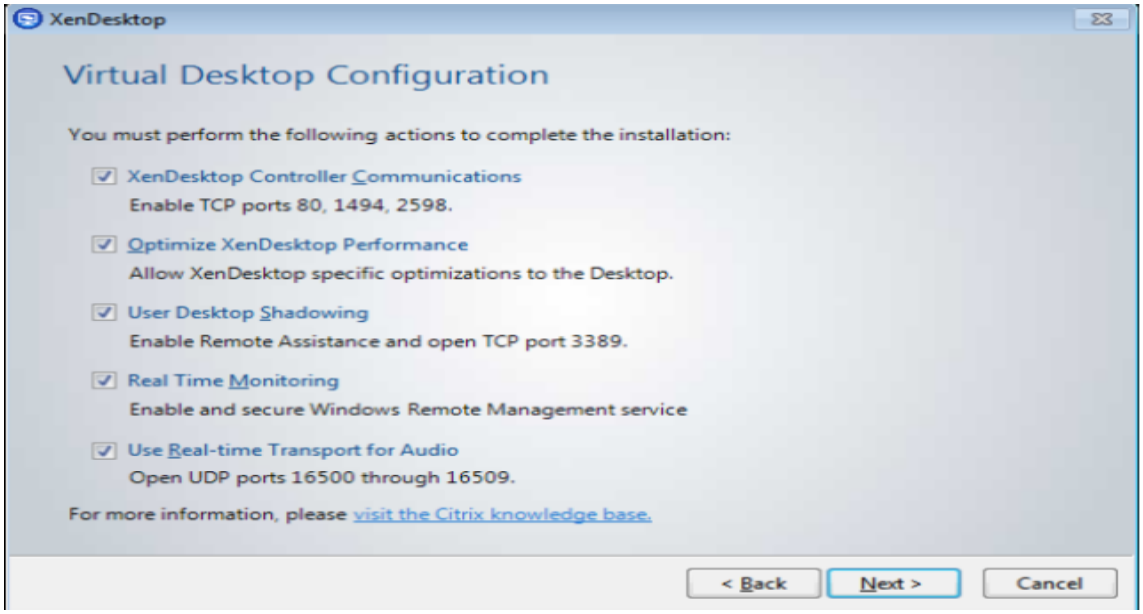


Figure 3.31: Virtual Desktop Configuration

Personal vDisk

Personal vDisk is a conventional customization solution for virtual desktops. The content of the vDisk is blended at run time with the content from the base VM to offer a unified experience. Two types of catalogs that facilitate vDisk usage are:

(i) **Pooled with personal vDisk**

It is managed with Desktop Studio Machine Creation Services.

(ii) **Streamed with personal vDisk**

It is managed using Citrix Provisioning services.

Additionally, a dedicated storage disk is devised prior to logon that redirects all changes made on the user's VM to a separate disk.

3.6.6 Machine Creation Services

Machine Creation Service involves specifying the machine type, choosing the master image configured earlier with VDA, choosing the number of VMs to be deployed, choosing Active Directory computer accounts configured in Domain Controller and determining the administrators permitted to use this catalog.

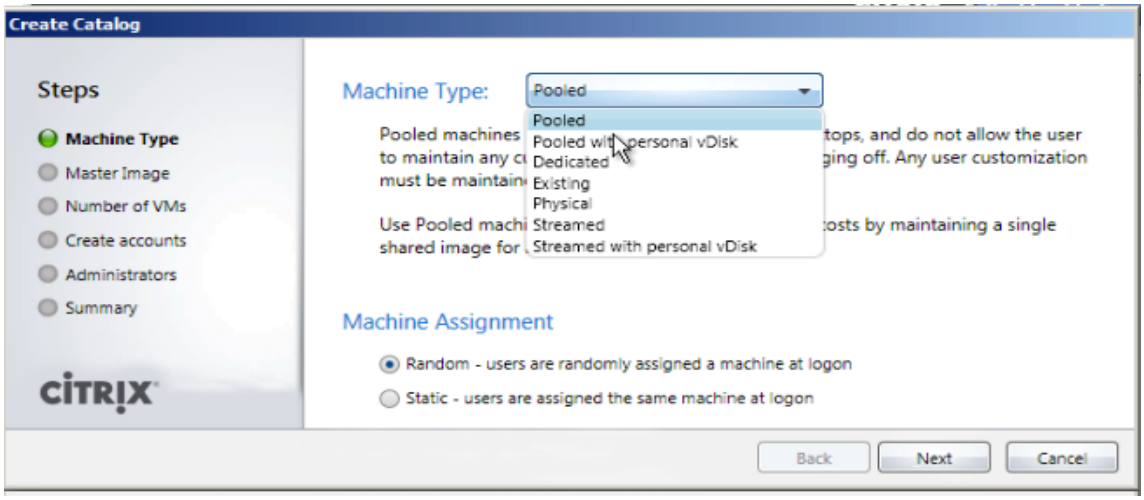


Figure 3.32: Create Catalog Wizard

Fig. 3.33 shows the summary. Fig. 3.34 shows completion of machine creation.

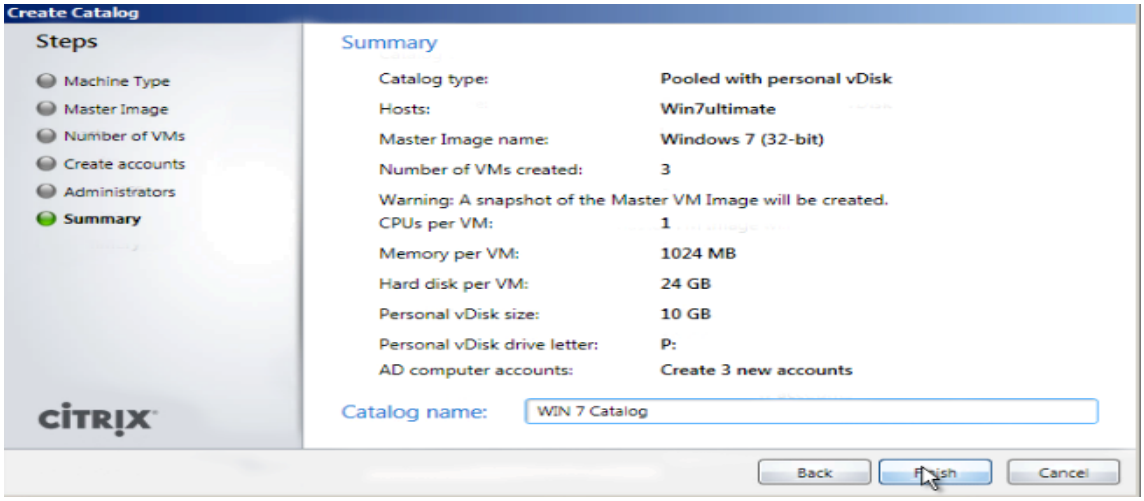


Figure 3.33: Create Catalog summary

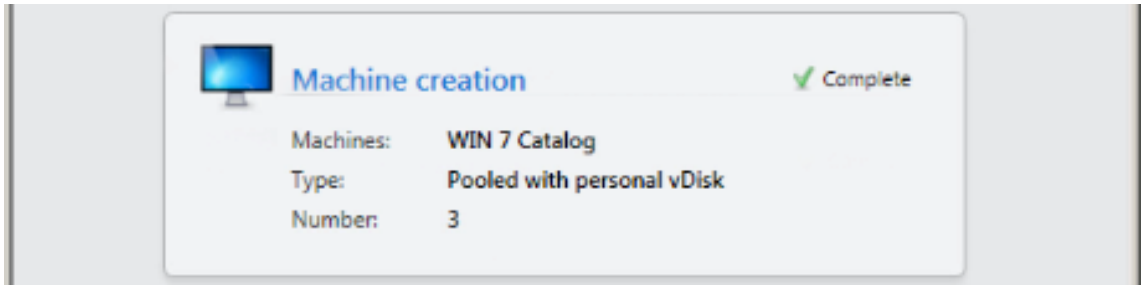


Figure 3.34: Machine Creation of type Pooled with Personal vDisk completed

3.6.7 User Assignment

User Assignment involves selecting the catalog created, adding active directory users, and delegating the help desk administrators that are permitted to manage this desktop group. Fig. 3.35 shows the User assignment summary.

3.6.8 Citrix Web Access Configuration

Fig. 3.36 shows the end user accessing virtual machine running on hypervisor on end-device using citrix online plug-in.

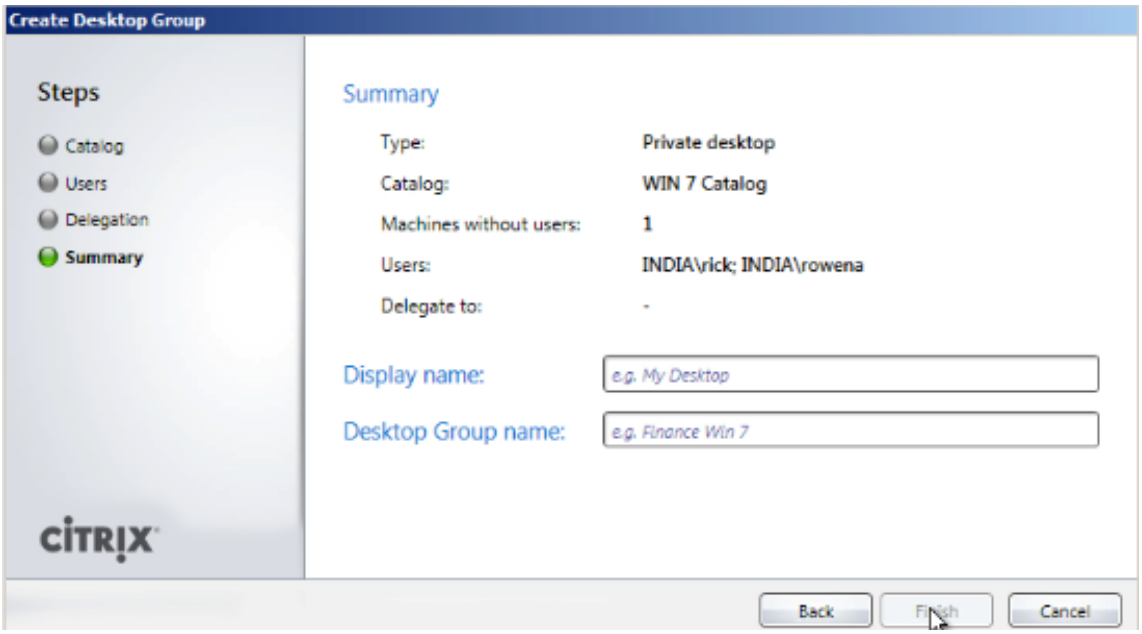


Figure 3.35: User Assignment Summary

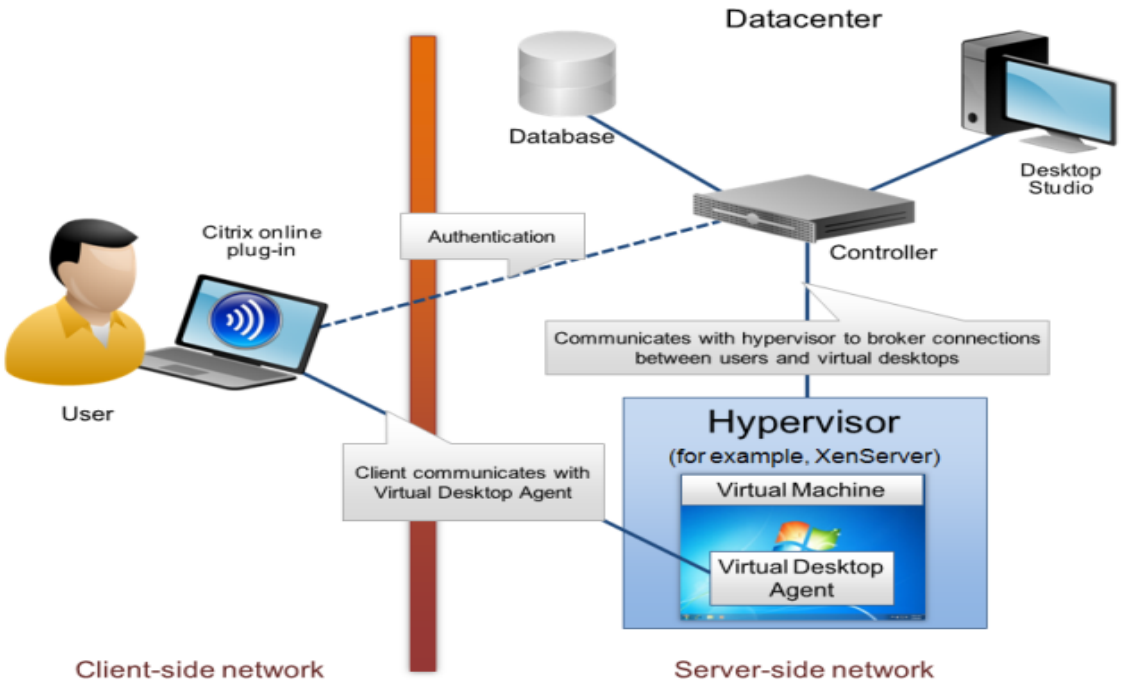


Figure 3.36: Desktop Deployment

3.7 XenApp

Citrix XenApp is an on-demand Windows application delivery technique that supervises & virtualizes all applications in the datacenter for optimized application performance & flexible delivery. Citrix XenApp (previously known as Citrix WinFrame Server, Citrix MetaFrame Server and Citrix Presentation Server) is a distributed approach to application deployment that bestows users instant connectivity to their numerous corporate applications from a variety of computer systems & mobile devices while ensuring highest level of control over sensitive data. XenApp is capable of hosting applications on the core server & subsequently permit users to communicate with them remotely or stream & deliver them to user devices for local execution.

With application virtualization, the applications are packaged to run in isolation directly on the users desktop system, or remotely on a server with the application interface displayed on the users' desktop, irrespective of the underlying operating system or platform.

XenApp Protocol

XenApp application hosting technology employs Citrix Systems' proprietary presentation layer protocol or thin client protocol known as Independent Computing Architecture. ICA describes a mechanism to send encrypted graphical output, along with other media such as audio, from the running application to the client. ICA transmits high-level window display information as opposed to purely graphical information.

3.7.1 System Requirements

- Operating System: Windows Server 2003, Windows Server 2008, Windows Server 2008 R2, Windows Server 2012
- CPU Speed: Minimum 750 MHz, 1 GHz or faster recommended
- RAM: Minimum 1 GB , 2 GB or more recommended

3.7.2 XenApp Roles and Features

The following roles and features are added using the add roles and add features wizard in the server manager:

(i) **Roles**

(a) Web Server IIS
Internet Information Services (IIS) in Windows Server 2008 R2 renders a secure, easily manageable, modular & extensible platform for reliable hosting of websites, services & applications.

(b) Application Server
Application Server renders an integrated environment for delivering & running custom, server-based business applications that are built with the .NET Framework.

(c) Remote Desktop Services (formerly Terminal Services)
Remote Desktop Services authorizes a user to take over the command of a remote computer or virtual machine over a network connection.

(ii) **Features**

(a) .Net Framework 3.5.1 Features
The .NET Framework is a technology that assists eastablishing & running the next generation of applications & Web services.

3.7.3 XenApp Architecture

Citrix XenApp Fundamentals is an architecturally robust application delivery model that facilitates small & medium-sized business users to securely access their corporate windows applications and documents from anywhere, either on LAN or at home, with an internet connection. The applications are safely stored on a central server & delivered to users, ensuring stringent security of sensitive business data and reducing management costs. A conventional XenApp architecture is shown in Fig. 3.37.

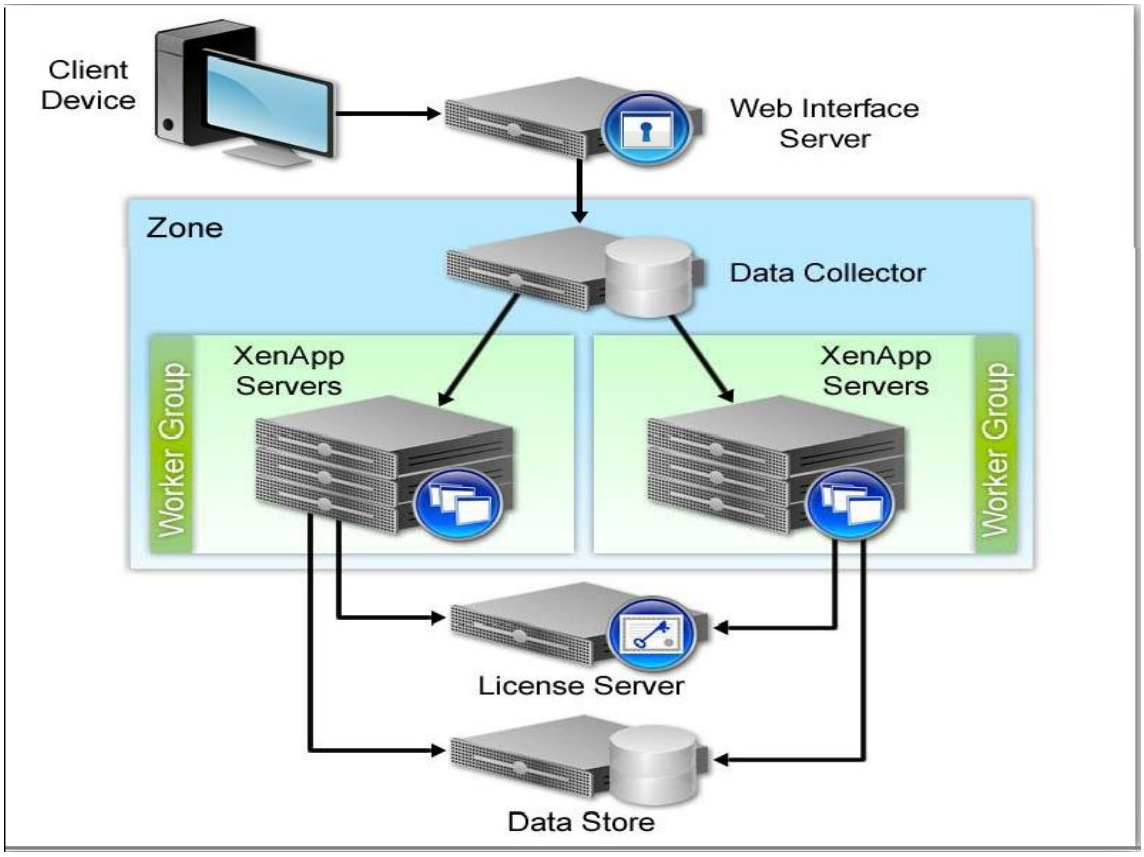


Figure 3.37: XenApp Architecture

The unified architecture of XenApp espedites application performance over any network connection and on any device. XenApp architecture consists of:

(i) **XenApp servers**

The XenApp Fundamentals servers host the published applications that users can run. In single farm environment, all XenApp servers use the same data store.

(ii) **Web Interface servers**

An inbuilt software module that enables applications published with XenApp Fundamentals to be accessed by users from a supported Web browser. AD & DNS services are required to resolve FQDNs for web interface & authenticate user access to the resources delivered by XenApp.

(iii) **Data collector**

A zone data collector is a server that administers dynamic information about the servers in the zone. Each farm has at least one zone Server role, which is responsible of collecting all dynamic data within a server farm zone.

(iv) **Data Store database**

The entire Citrix implementation is invested in a central repository known as the data store. The Administrators of the farm, the license server to point to, the whole farm configuration, the published applications, all their attributes & policies, the access security boundaries, the custom load evaluators, authentication policies, configured printers and print drivers, all this is administered in the central repository called the data store. The SQL database hosts the XenApp data store, which provides the foundation for all configuration data in the XenApp farm.

(v) **License server**

A Citrix License Server is necessary for all XenApp deployments. The license server is installed on either a shared or standalone server, based on the farm's size. After the installation, the appropriate license files are to be downloaded from the MyCitrix.com website and installed.

(vi) **Worker groups**

Worker group is an assembly of similar XenApp servers, residing in the same farm, that are managed as a single unit. Worker groups provide:

(a) Streamline application publishing to multiple farm servers

(b) Load balance access to published resources

(c) Filter policies so that settings are applied only to sessions hosted on a specific set of farm servers

3.7.4 XenApp Configuration

The Citrix Delivery Services Console is a tool that snaps into the Microsoft Management Console (MMC) and empowers us to perform a number of management functions. XenApp Fundamentals is configured to choose the subset of installed applications that should be made available to users based on their role & location in the organization.

All the applications that are to be deployed to the users are required to be installed on the XenApp servers. A publish application wizard opens on clicking Publish application in the right action pane as shown in Fig. 3.38. The steps that follow include providing name, detail, type and location of the application, along with the home server details and configured Active Directory users.

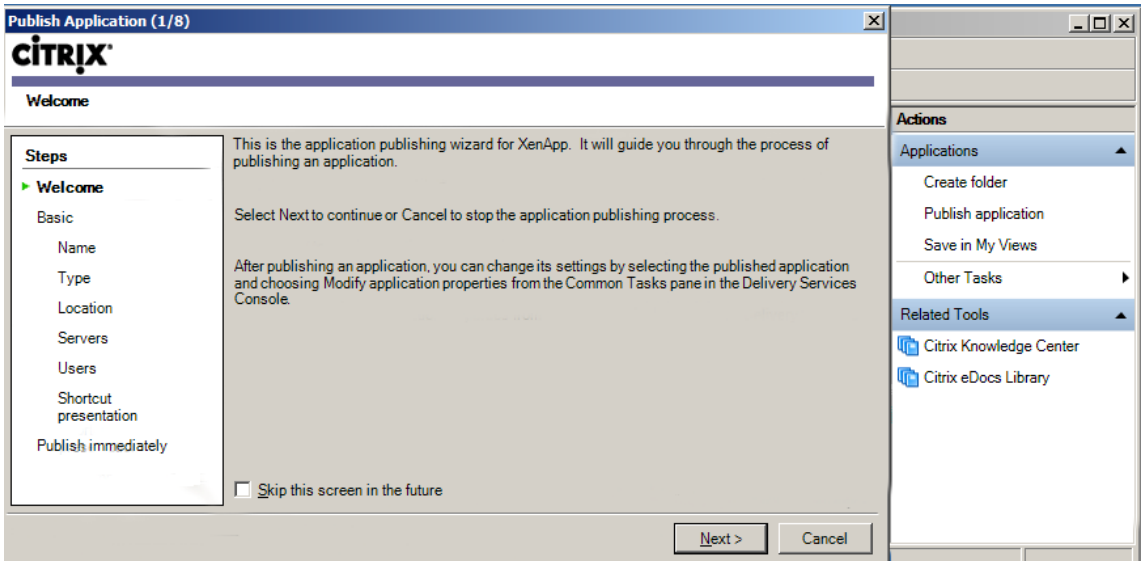


Figure 3.38: Publish Applications Wizard

The delivery console administers the applications to be deployed. Fig. 3.39 lists the applications deployed to the user.

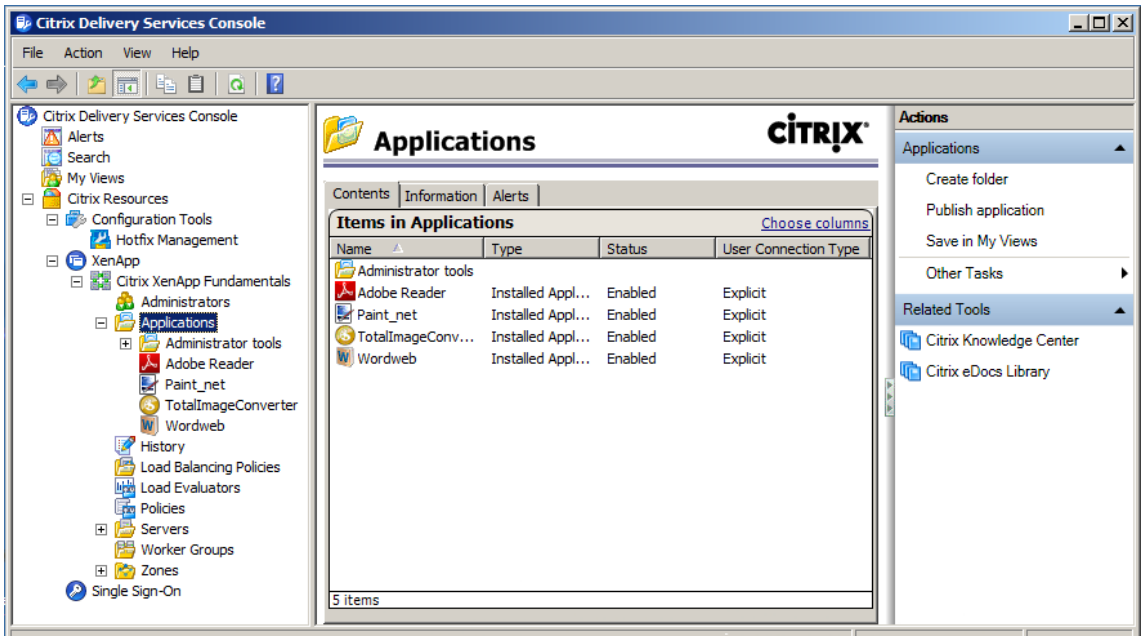


Figure 3.39: Citrix delivery Services Console

3.7.5 Application Deployment

Using XenApp, an application can be deployed to the users either by streaming it to the user's virtual desktop or by hosting it on the XenApp server.

(i) **Application streaming**

Application streaming simplifies delivery by allowing you to install and configure an application on one file server for delivery to desktops.

(ii) **Application hosting**

Application hosting makes applications available to users from the XenApp server, instead of from their desktop. When a user runs an application that is published on XenApp, the application is virtualized on the desktop and so appears to the user to run locally. However, the application is running on the XenApp server in a separate protected ICA session, which keeps application processing on the endpoint device to a minimum.

Fig. 3.40 shows the three main options for application deployment in a XenDesktop environment. In the first desktop, the application is installed on the

virtual desktop image; in the second desktop, the application is streamed from XenApp to the virtual desktops local hard-drive; in the third desktop, the application is available as a published (hosted) application from XenApp.

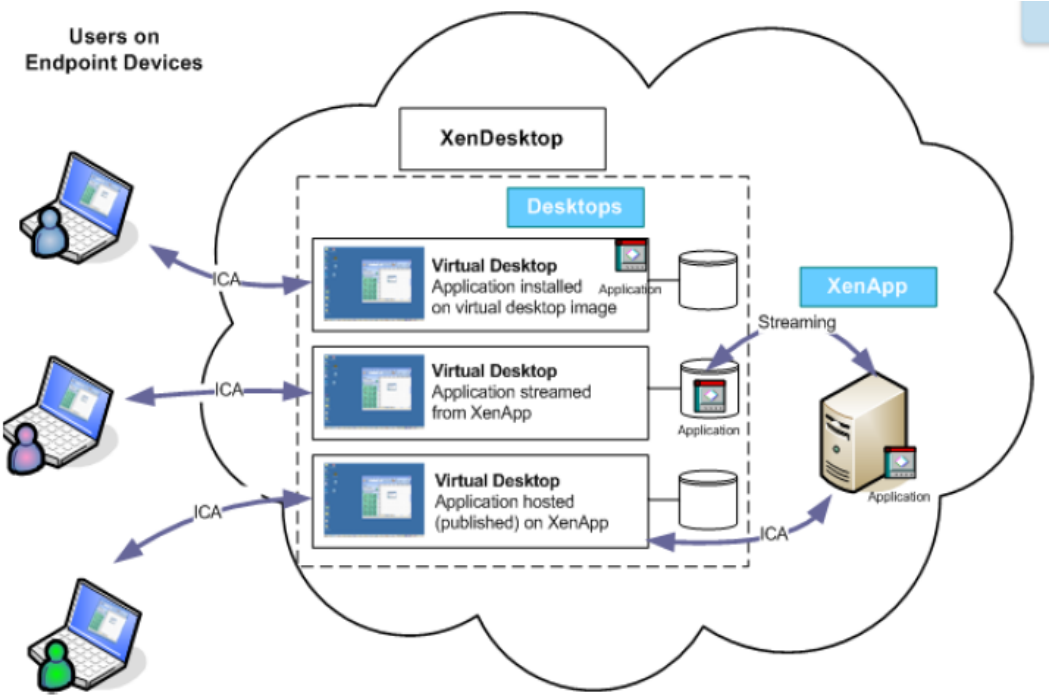


Figure 3.40: Applications Deployment

Chapter 4

Private Cloud Client Side Architecture

4.1 Introduction

The applications of cloud computing are practically limitless. Cloud applications have made on-line association more accessible than ever before. Cloud architecture provides access to personal profiles, shared data, documents, calendars & business files. The cloud infrastructure needs to accommodate various kinds of clients, including PCs, smart phones, tablets, & more. A well designed user experience & visual interface forms an important criterion of a successful cloud application. The users must be able to request & access the virtual infrastructure conveniently. Moreover, the front end must be modulated according to the security policies of the cloud provider & user.

4.2 Citrix Xen Web Self Service

Xen Web Self Service can be accessed by users anywhere on the local network using a web browser and authorization credentials. The users can choose among a wide range of operating systems at the ease of a mouse click. Xen WSS plug-in provides access to desktop services by pointing at the web URL generated by Xen WSS as

shown in Fig. 4.1. The OS runs in the browser interface of the client desktop.

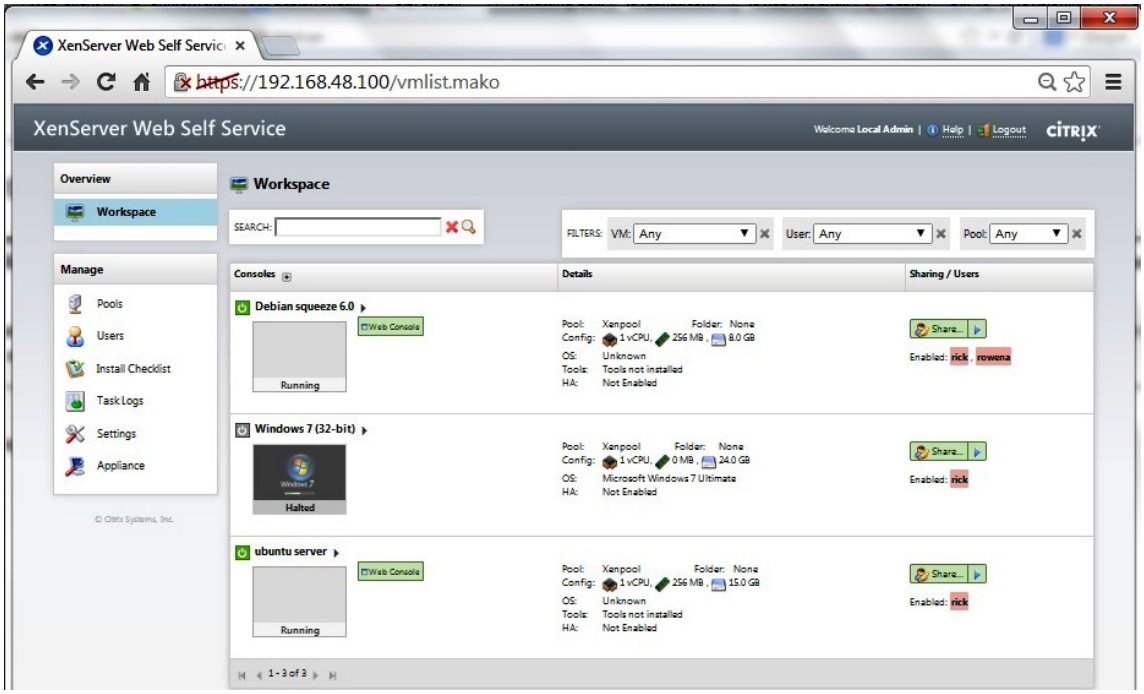


Figure 4.1: WSS Workspace

4.3 Citrix Receiver

Citrix Receiver (formerly ICA client) is the enterprise app store that allows client devices to connect to various desktop virtualization services offered by Citrix that simply and securely. Versions exist for many different types of client platforms and form factors, including Windows, Windows Mobile, Blackberry, Mac OS X, iPad, iPhone, Android, Blackberry Playbook, Linux, Google Chromebook, thin clients, zero clients, & embedded operating systems. Citrix Receiver connects client devices to XenApp & XenDesktop applications and desktops via the HDX protocol.

The user devices are required to have a supported plug-in & web browser to operate with XenApp Fundamentals. Users enter their domain credentials (user name, password, and domain) to connect to XenApp Fundamentals through the Citrix Web Interface mapped to TCP port 80. Fig. 4.2 shows the user plug-in for

application access.

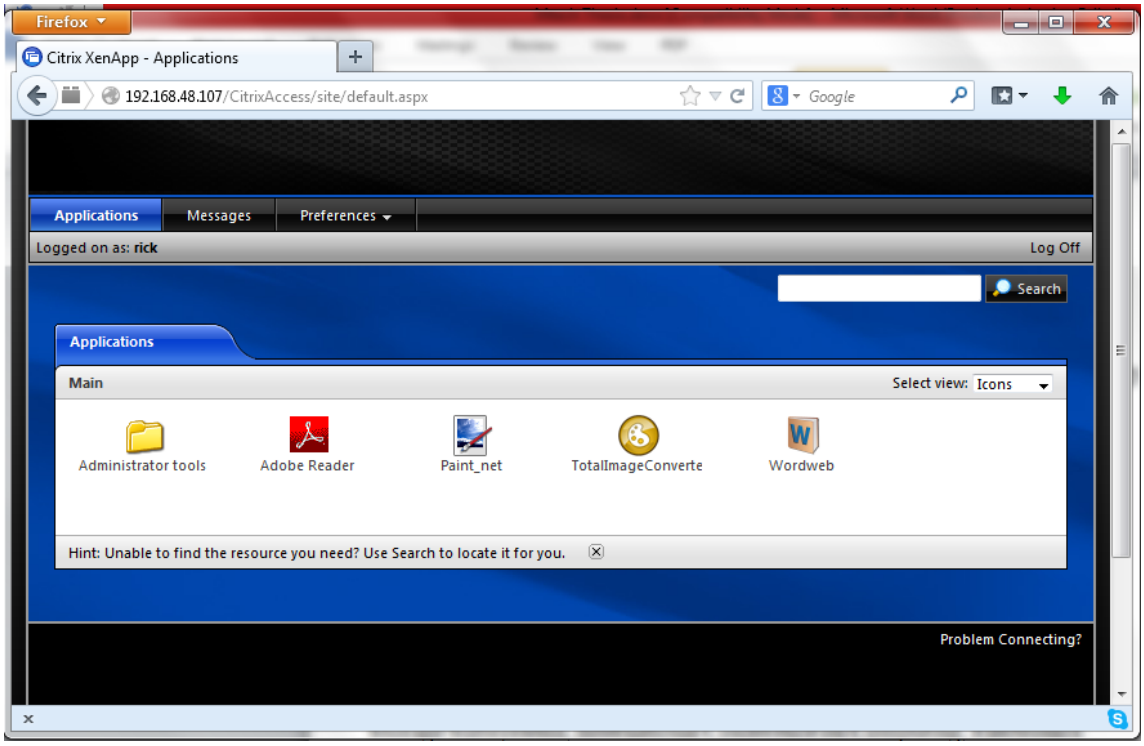


Figure 4.2: Citrix XenApp-Applications: User Plug-in

Chapter 5

Performance Analysis

5.1 Monitor IT

MonitorIT is ushering in a new paradigm in monitoring servers, workstations, applications, databases, network, & storage components. Monitor IT is installed on domain controller and can be accessed by pointing the web browser to http://<ip address of domain controller>/Top.htm

5.1.1 System Requirements

- MonitorIT Server Platform: Virtual Machine or Physical Server
- OS: Windows Server 2003-2012 ; 32bit/64bit
- Network: Static IP Address
- Memory: Minimum 2 GB
- Disk: Minimum 15 GB of Disk Space
- Firewall Monitor IT Server: TCP ports 80 & 82 both must be open inbound; & port 80 must be enabled outbound for remote access to the console.
- Citrix XenCenter Plug-in XenCenter: Version 5.5 & newer

5.1.2 Performance Metrics

Fig. 5.1 shows % CPU Usage, % Memory Usage and % Page/Swap Memory Use of Windows Server 2008 R2 domain controller.

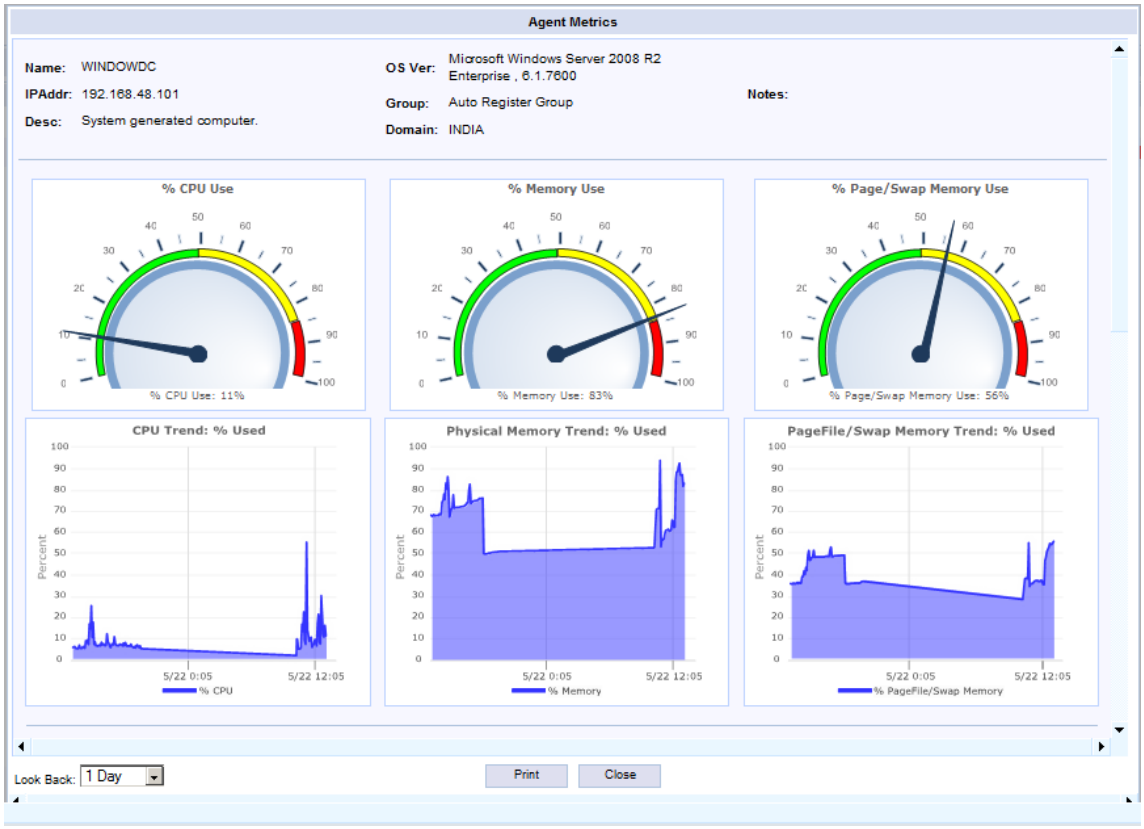


Figure 5.1: Domain Controller Metrics

Fig. 5.2 shows % CPU Usage, % Memory Use and % SR Space Use of master XenServer host in the Xen Resource pool. The virtual machine list gives the list of machines running at the time of performance query.

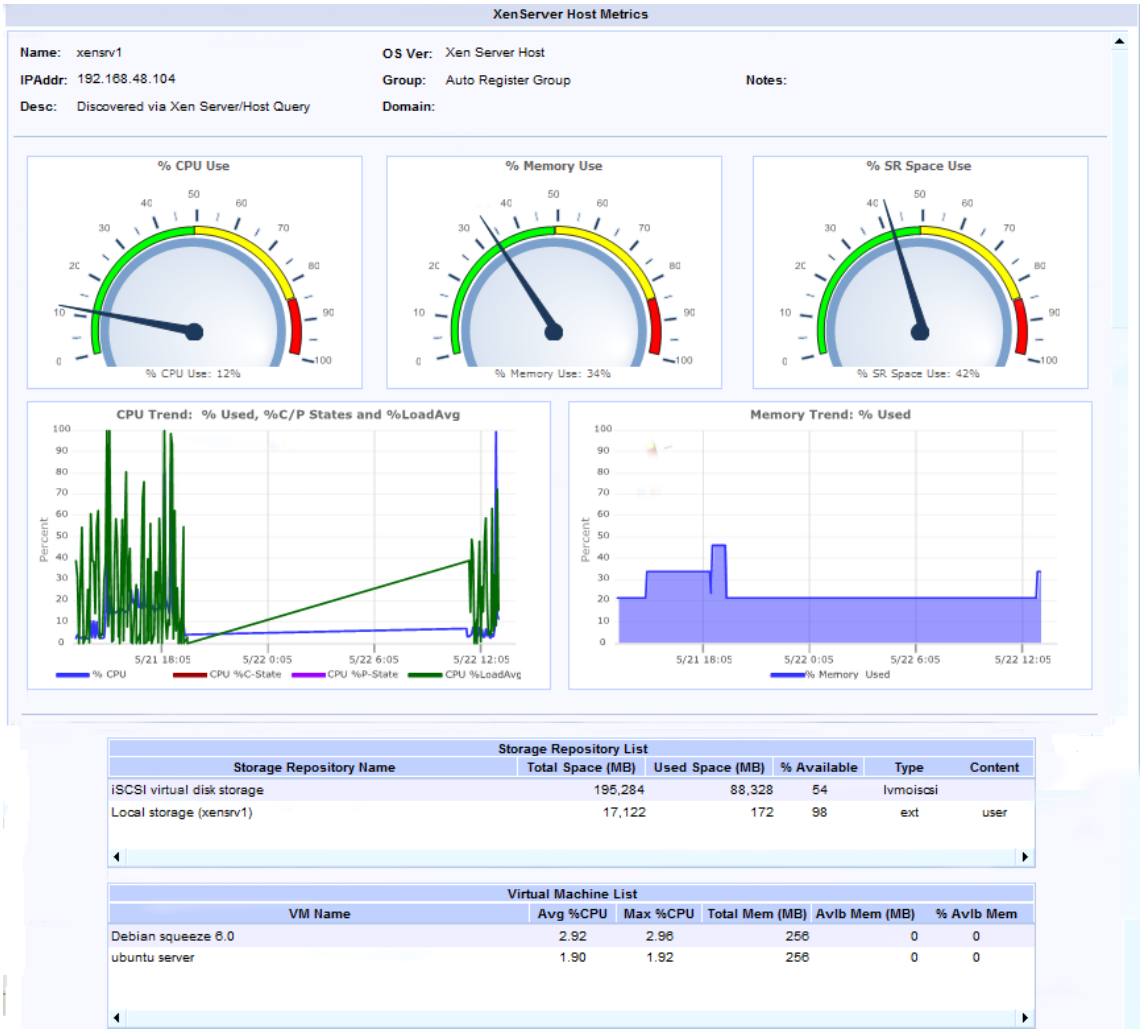


Figure 5.2: XenServer1 Metrics

Fig. 5.3 shows % CPU Usage, % Memory Use and % SR Space Use of secondary XenServer host in the Xen Resource pool. The virtual machine list gives the list of machines running at the time of performance query.

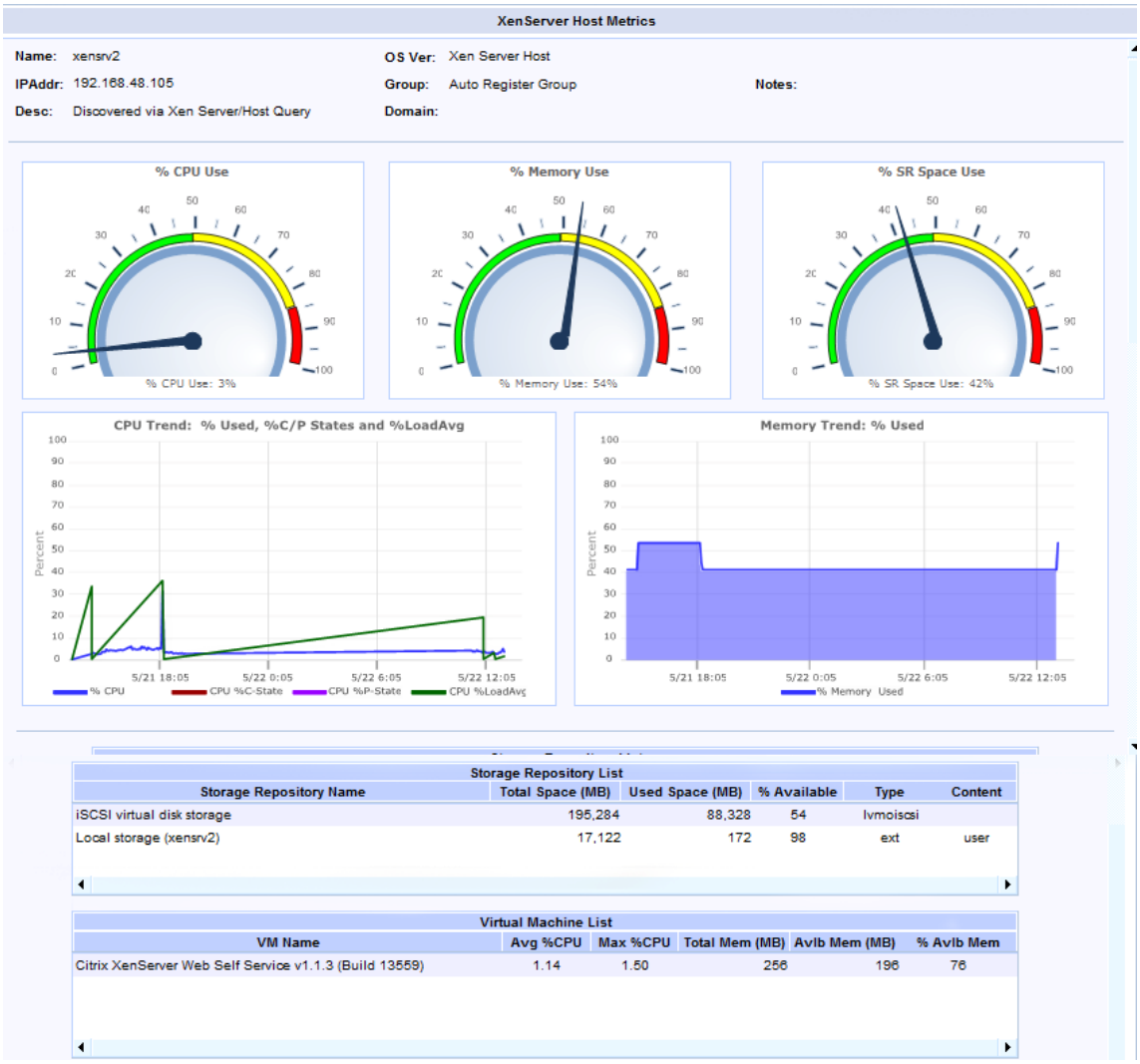


Figure 5.3: XenServer2 Metrics

Chapter 6

Conclusion

6.1 Conclusion

Cloud computing is the major area of research work for service developers and to scale up the cloud applications for usage at efficient level. Virtualization in combination with utility computing model can bring a huge change in the IT industry as well as in social perspective.

This thesis presents the implementation of a private cloud infrastructure using Citrix open source softwares at affordable smaller scale and highly customizable according to user needs. It is important to note that such a cyber implementation enables the deployment of a private cloud using heterogeneous resources, composed by common hardware usually found in academic environments. Users dont have to be worried about the hinges of distributed programming and can devote more on their own domain work rather than these administrative works. This cloud infrastructure not only provides easy access to application on the network, but also provides different varieties of computing environments that fits the need.

Cloud services open the doors to approximately infinite computing capabilities, scalability, pay-per-use scheme and so on. This shows that the fifth generation of the computing in the form of cloud computing now begins.

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